CIVIL ENGINEERING

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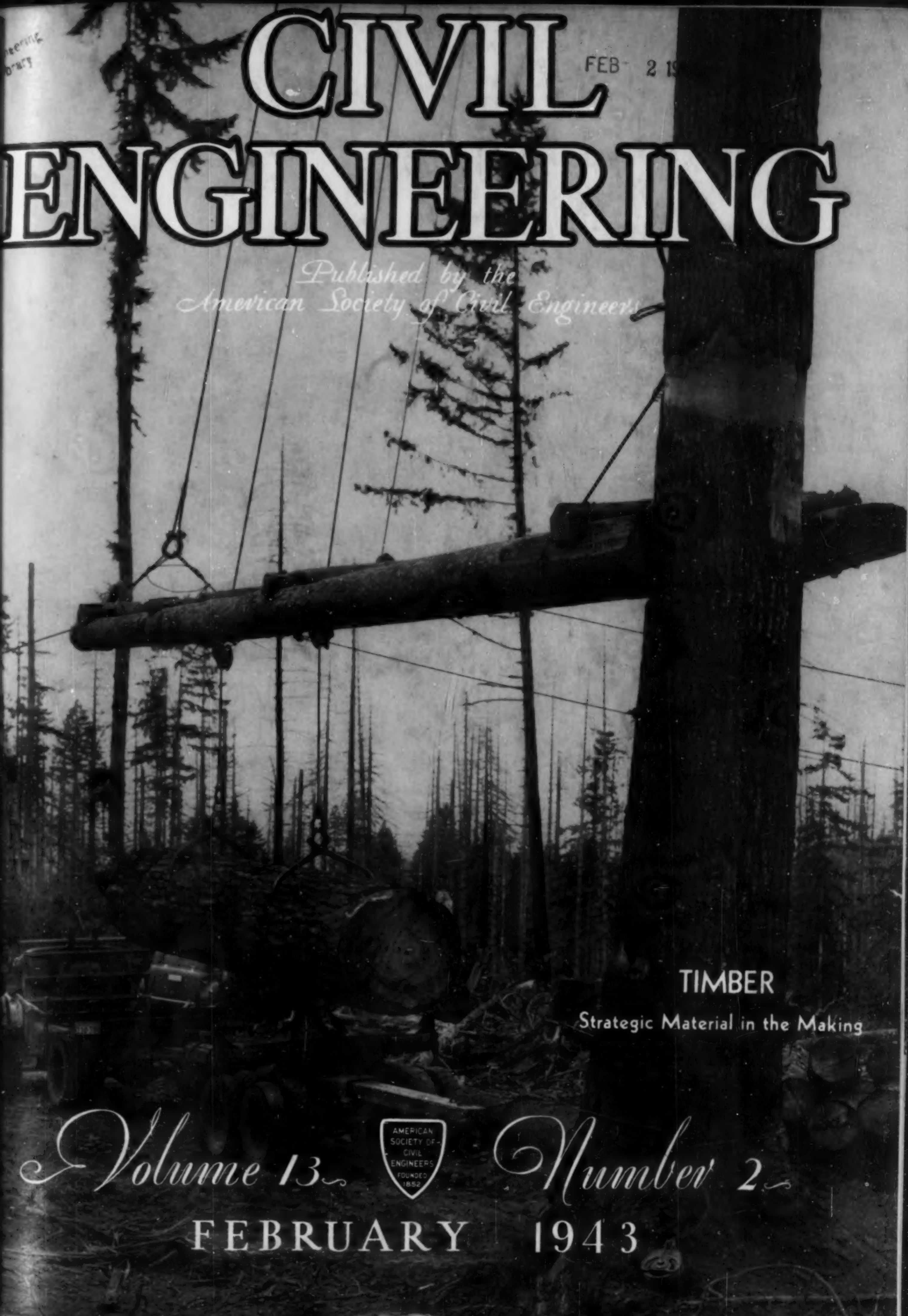

TIMBER

Strategic Material in the Making

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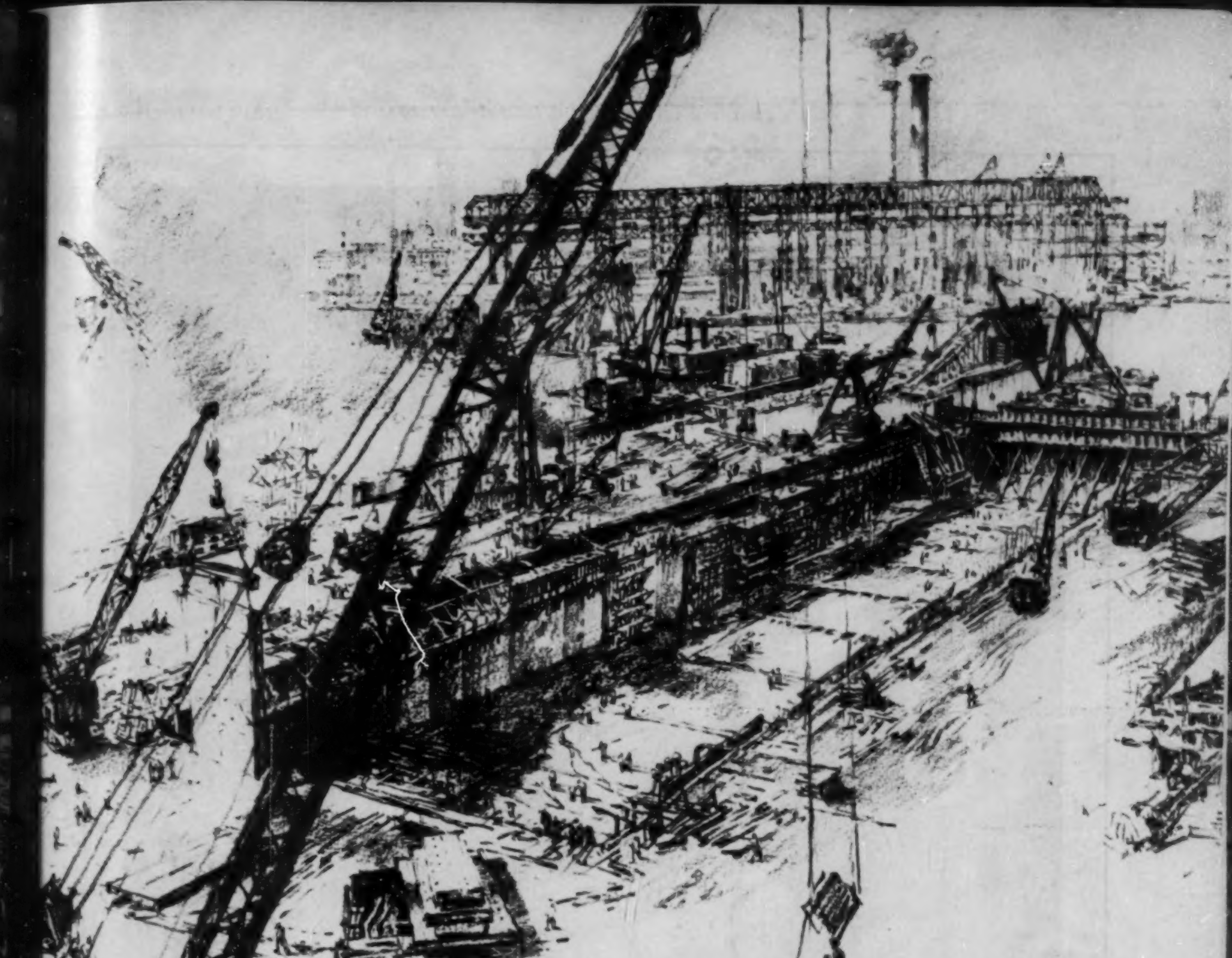
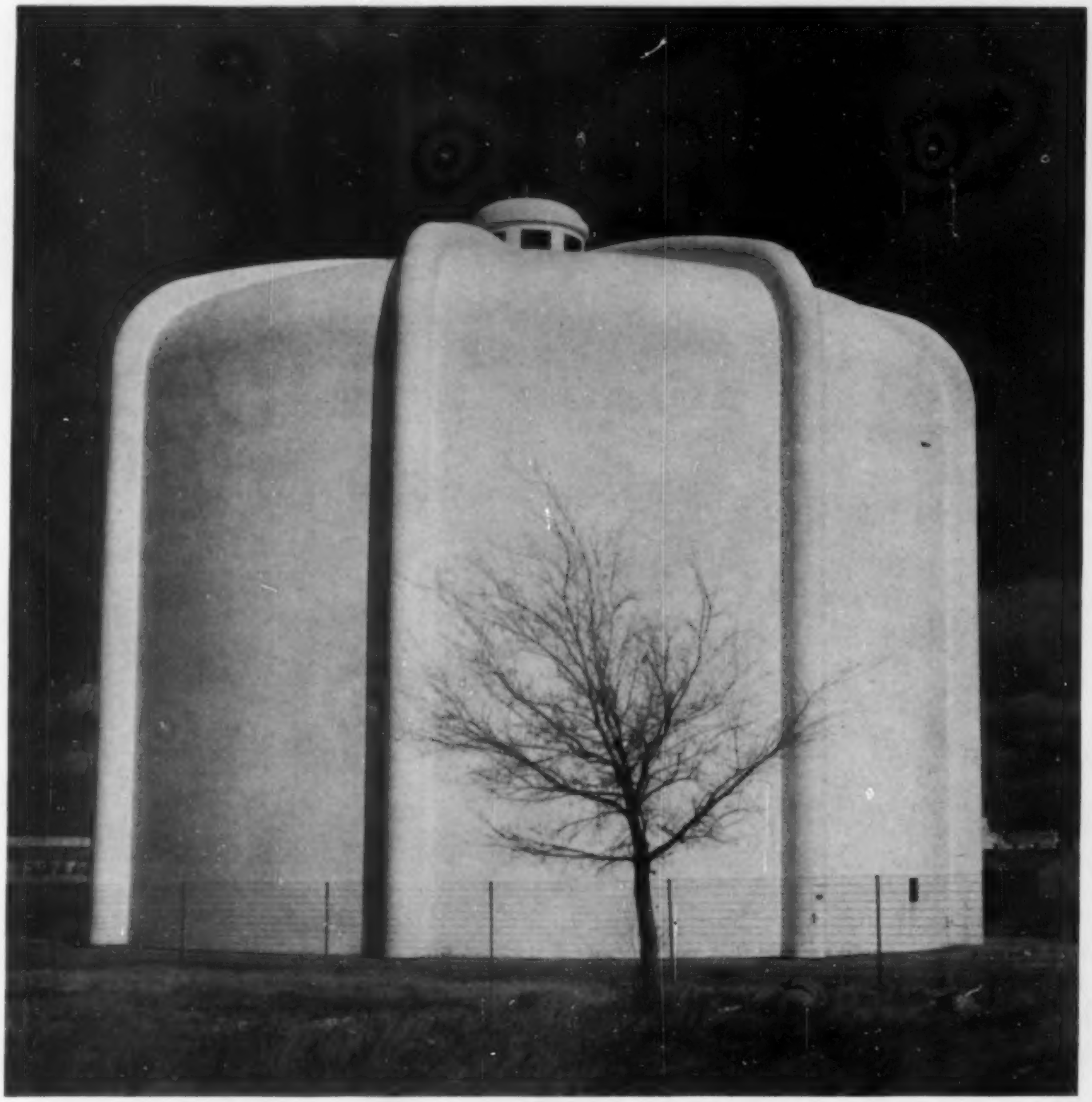


WAR CONSTRUCTION

Navy Dry Dock

Lili · Réthi 1942



Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Economics in the War Effort

Digest of Address Before Society's Convention in Minneapolis, Minn., July 22, 1942

By R. A. Stevenson

Dean of School of Business Administration, University of Minnesota, Minneapolis, Minn.

EVERYONE is conscious of the important part that economic resources play in total war. The confusion on the economic front that has been evident so far must be particularly distressing to the engineer who, by the nature of his profession, is precise, definite, and exacting. Given a problem for the construction of a plant, the engineer proceeds by definite steps from the original plans and design to specifications, to actual construction. Why have not the economists been able to convert the economic system to a war basis along the same definite, logical, and precise lines?

Economics Differs from Engineering.~In answering this question it should be pointed out that the engineer has one very great advantage over the applied economist. The basic laws or principles in the engineering sciences are universal in their application and cannot be altered or tampered with by the acts of man. There are some immutable laws in economics but they operate in the sphere of man-made institutions, and therefore are subject to manipulation. The economist could state definitely the outcome of a specific policy if he were able at the same time to determine—or control—all the conditions that would have any bearing on the case. He never does meet these conditions in actual practice, however, and so he must qualify every generalization.

Economists now in Washington attached to the various agencies are attempting to set in motion the economic forces that will produce a fairly definite result. In appraising their efforts it is well to keep in mind the limitations under which they work. They may make use of the scientific method but they are unable to set up the controls of a laboratory experiment.

War Economy Demands Coercion.~In 1940 we had practically a complete civilian economy. In 1941 approximately one-sixth of the total resources were devoted to the defense and war effort. By March of 1942 more than one-third of the total national income was expended on war and before 1943 has passed we will be devoting well over half of our economy to it. An even greater proportion may prove necessary to swing the tide of battle against the Axis countries, which have for some years been putting as high as 70% of their resources into war activities.

Obviously the necessary conversion to bring about these results within the time limits could not be accomplished through reliance upon the automatic free market system. If ample time had been available, the government could have bid for the use of resources at prices which would have diverted them from civilian purposes. Under stress of war, however, the time required to accomplish the result by this process would have been fatal. This was the problem proposed to the new economic hierarchy in Washington. Nothing comparable in the way of centralized planning and direction has ever before been attempted in the nation's history.

All Resources Mobilized.~The justification for the assumption of controls over business and the consumer is that we are engaged in a total war. The nation is willing to forego the privileges of a free-enterprise system temporarily in order that all the resources of the country can be devoted to the single purpose of winning the war. Total war means that the maximum proportion of all the economic resources must be mobilized and utilized as an integral part of a great fighting unit.

There doubtless is public acceptance of the thesis that all our resources must be devoted to the war effort. What is needed now is a general staff for economic warfare, with all the authority and responsibility that applies to the command of the armed forces.

General Staff to Attack Bottlenecks.~It might be argued that a unified economic command would spell the doom of the free economic system. This argument has very little force in the present situation. In the first place, we have already abandoned the free competitive system for the duration. Setting up a general staff with authority would merely increase the efficiency of the controls already established.

The chief problems on the economic battle-front so far have been the "bottlenecks" that threaten the production of war supplies, such as scarce materials, capital plant, and machine tools. As the peak of the war production program is reached, the most serious bottleneck will be labor. The best estimates at present indicate that we will need from 61 to 63 million for war production and for combat when we reach this peak. At the close of the year 1941 the total labor supply of the country

was 55.4 million, made up of 2.1 in the armed services, 49.4 million employed, and 3.9 million unemployed. In 1943 there will be nearly 10 million in the armed services. In addition there will be a need for 55 million workers in war industries. After all workers in nonessential industries have been shifted to war industries an additional 6 to 8 million workers will still be needed.

Obviously this deficit can be made up only by bringing into the labor supply large numbers who normally would not be employed in factory work. It is quite unlikely that a sufficient number of women will be attracted by the prevailing high wages to fill the breach. There appears to be no other solution than that of a selective service for the war industries. It is reasonable to predict that such a system will be in operation in 1943.

Inflationary Dangers Also.—The second major problem on the economic front is the equitable distribution of the available supplies of consumers' goods, which will diminish steadily as the problems of war production are solved. The large increase in the incomes of civilians incident to the enlargement of the national income would create scarcities even if the supplies remained constant.

Economists are agreed as to the means of preventing inflation. The tools consist primarily of fiscal policies of the government which can be used to drain off or recapture the excess purchasing power in the hands of the civilian population. Taxation and government borrowing from the current savings to an extent sufficient to cover the war costs would hold the price level in check. Yet despite the universal acceptance of the effectiveness of these devices, there is little evidence that they will be used with sufficient vigor to prevent inflation.

Consumer Rationing Is the Answer.—After giving full weight to the amount of purchasing power that will be taken through taxation and through the sale of war bonds, there will be an excess of funds available to consumers of approximately 21 billion dollars during the next year. That constitutes more than a threat of inflation—it is a guarantee that there will be a vigorous inflationary movement unless some other means are employed to prevent those in possession of the excess funds from bidding up prices in the consumer markets.

The one means available is a consumer rationing program. So far rationing has been limited to a few commodities, but it will not be long before rationing will be applied to all staple consumers' goods.

Experience of other countries bears out the contention that an extensive rationing program is essential in preventing price inflation. So far we are about midway between Germany and Great Britain in the financing of the war out of current income and will doubtless be forced to adopt rationing programs comparable to theirs even though the amount of consumer goods available for distribution is vastly greater than that in either of those countries.

The alternative to spending is saving, of course, and the surplus funds become available for the purchase of government bonds. Thus a rationing program is a very important adjunct to the government's fiscal policy.

Economic Control Made Complete.—Obviously a rationing system involves an enormous amount of administration. The setting of quotas based upon estimates of supplies on hand or under production is even more complicated than the setting of priority programs for war production. It requires a vast army of administrative agents both for establishing the rules and for supervising the operations.

With the introduction of a rationing program, the final step is taken in bringing the economic system under government control. The individual, both as producer and as consumer, is under rigid supervision. It was inevitable that the controls be made thus complete from the time the first steps were taken, because the entire economic machine is so delicately balanced that interference at one point leads to complications in other parts unless they too are controlled.

Such organization of our economic system is extremely distasteful. The controls imposed upon business are not only irksome but they are also costly and in many instances impede efficient operation. Likewise the consumer will chafe under the restrictions that allow him to consume only those goods that the government permits, in quantities and at times specified. These are unpleasant developments, particularly in a democratic society. But war itself is not a pleasant undertaking. If all these controls are essential to assure the full mobilization of our resources in a total war, then they are justified.

Economic Freedom Afterward.—The responsibility of the economists both in Washington and outside the government service will not be fulfilled unless they develop a plan for the post-war period. This should involve demobilization of the organizations for government control of our economy. The establishment of the machinery for efficient control for the purpose of expediting the war effort involves the temporary loss of some of the freedoms for which we are fighting. When the war is over those freedoms must be restored as promptly as possible.

There are some who fear that it will be impossible for the government to relinquish the power it has assumed over the economic system during the war. There is probably less to fear on that ground than on the ground that the controls will be removed too abruptly. If this happens without some carefully laid plans on the part of private enterprise to take over the responsibilities of an ordered peace economy, we may experience again the exultant boom of the twenties and the subsequent depression of the thirties.

In the period immediately following the war, incomes and buying power will still be extremely high, while supplies of available goods will be extremely low. During the period of conversion from war production back to production for civilian needs, it would be wise to maintain sufficient controls to prevent a sudden rise in prices.

For Post-War Planning, Now.—Plans for the post-war period will have to be made considerably in advance of demobilization. There is a disposition on the part of many to dismiss from consideration at this time all post-war planning on the ground that the only thing that counts is to win the war. To be sure, the winning of this war is the supreme task, but it does not follow that thought given now to conditions following the war will interfere with, or diminish, concentration on the war effort. Not to plan now for conditions that are to follow is to subject the country to needless danger. To be caught unprepared to deal with the conversion of a war economy to a peace economy is as inexcusable as to be caught unprepared for military aggression.

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Special Features Mark Addition to May Company Building, Denver, Colo.

By WALTER H. WHEELER, M. AM. SOC. C.E.
DESIGNING AND CONSULTING ENGINEER, MINNEAPOLIS, MINN.

ERECTION of an eight-story addition to a commercial building in the heart of Denver involved special consideration of existing structures and of underground utilities. Connection of the new steel and concrete to the earlier reinforced concrete structure also involved an interesting detail. The combination of steel columns and reinforced concrete slabs without drop panels was made possible, as Mr. Wheeler explains, through a patented system of steel grillages embedded in the floor slabs.

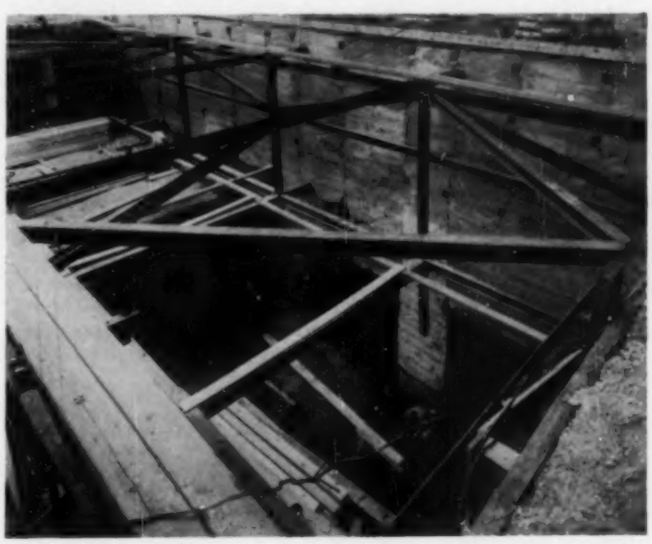
TO meet the need for additional display floor space, the May Company of Denver, Colo., decided to erect an addition adjacent to its store, on the site of old commercial buildings which had outlived their usefulness. An important condition was that the construction operations should be carried on without interruption or inconvenience to retail trade in the old store buildings. This condition applied alsoto the necessary alterations in those buildings. Further conditions were that floor levels should be continuous from the old to the new building and that underground utility mains should be left undisturbed. The addition was to have eight stories, plus basement and sub-basement.

The original building, Fig. 1, is 4 stories and basement with a new sub-basement, and was constructed with steel framing and columns on the two street fronts; cast-iron columns, steel girders, and steel beams on the interior; and masonry bearing walls on the alley and original lot line. The slabs are short span, of reinforced concrete. In 1926 a section was added and the bearing wall on the lot line removed. This earlier addition is 6 stories high, with basement, of reinforced-concrete skeleton frame and flat-slab construction. The concrete columns have capitals, but no drop panels.

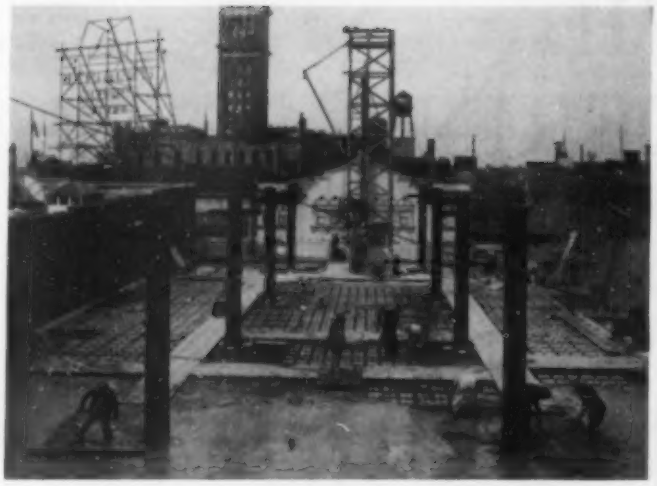
To this composite structure was added the new building, which is also of skeleton frame and concrete floor-slab construction but of a newer type. No flared capitals or drop panels were used on the columns. The interior columns are steel H-sections to which the steel grillages of a patented process are connected at each slab level. These grillages, Fig. 2, except at the sub-basement floor, are set $1^1/_4$ in. above the bottoms of the concrete slabs. They are made of 6-in. ship channels which intersect in a plane and are electrically welded. The grillages, after prefabrication in a welding shop, were riveted through the webs to the H-columns and to four shelf angles, which were also riveted to the columns under the grillages to complete the connections. In some other jobs where this type of grillage has been used they have been welded to the steel columns, but in most cases riveted connections have been used. The grillages and their connections were designed to support the full live and dead load of the slabs and also to withstand unbalanced loading. In the design they were given their full value in the compution of shear and bending.

The slabs in the new building are two-way, with tile filler blocks designed according to the requirements of the American Concrete Institute and the Denver Building Code. The basement floor is a flat slab. The sub-basement floor is also a flat slab designed for a hydraulic uplift pressure of 1,000 lb per sq ft on the bottom of the slab. The steel grillage for the sub-basement floor was inverted, as was also the flat-slab reinforcement, to take the net uplift pressure. No pedestal or enlargment of the column was required above the sub-basement floor, as the grillage performs the functions of the usual concrete capital. In all other slabs, except the alley end of the first-floor slab and the sidewalk slab on Curtis Street, the clay tile fillers (12 by 12 by 6 in.) were spaced about 16 in. on centers both ways.

Fillers were omitted from the area around the columns where there is negative moment in the slabs. Cardboard closers were attached to the ends of the fillers by metal clips to keep out the concrete. The slab reinforcement is proportioned so that one bar is required in each concrete



COFFERDAM BRACING FOR SUB-BASEMENT EXCAVATION, SHOWING CONCRETE UNDERPINNING FOR OLD THEATER BUILDING WALL



Typical Floor of Addition During Concreting
Grillage for Next Floor Attached to Columns

joist; alternate bars are bent up to provide negative reinforcement.

At the Curtis Street front of the building, reinforced concrete girders span about 61 ft. This clear span provides for continuous glass-block windows and also leaves the show windows clear of columns. The present eighth story is a large penthouse that is framed with steel columns and steel beams and covered with steel roof decking. The steel is bolted so that it can be readily dismantled and moved up when the permanent roof slab is built over the eighth story at some future time.

NEW FLOOR ADDED IN OLD BUILDING

The boiler plant which was in the basement of the old building was removed and replaced with a new plant in the sub-basement of the new addition. A new basement floor of solid concrete flat-slab construction was built over the old boiler room space to provide a sub-basement for utilities in the original building. The steel grillages for this floor are supported on concrete shells built around the cast-iron columns in the sub-basement.

A public alley between the new and old buildings has been kept open in the first story. The basement has, however, been extended under this alley.

This alley created a major design and construction problem. Under it and about 3 ft from the old buildings, are the transcontinental cables of the Bell Telephone Company. About 3 ft from the other side of the alley are the 2,300-v cables of the public service company for downtown Denver. These cables are in conduits enclosed in concrete protection. Excavation for the sub-basement extended downward about 40 ft below alley grade. The south wall of the cofferdam thus had to be driven between the outside of the new wall on the alley line and the power cables. Column footings along the north alley line were designed so that they would not project into the alley space or beyond the east and west property lines. A combination of cantilever and combined footings was used.

At the site the soil is sand and gravel to a depth of about 25 ft, and below that is hard blue clay, said to be several hundred feet thick. Locally it is called shale. It is hard, dry, and compressed, but when saturated with water becomes soft and disintegrated. The ground water flows over this clay in the lower part of the sand and gravel strata, but does not seem to penetrate the top of the clay in place.

The walls of the existing buildings on both sides of the sub-basement were underpinned with concrete before the excavation for the sub-basement was made. Small cribbed shafts were sunk, one at a time under the walls down to the required depth, and a section of the underpinning was placed in the crib. Jacking was done before the final lift of concrete was placed to prevent settlement of the walls. Fortunately no heavy flow of water was encountered in the excavations, and the water that came in was readily handled by pumping from sumps in the bottom of the excavations.

The contractor obtained permission to set up a temporary boiler plant in the alley adjacent to the old boiler room so that the stack of the old building could be removed before the sub-basement was completed. This arrangement made it possible to take down the old wall and simplified the shoring and the whole procedure so far as this wall was concerned. The cofferdam and all major shoring as originally contemplated were designed by the structural engineer and made a part of the contract plans and specifications, so that the bidders would have a definite plan of operation on which to base their bids.

The design was based on the log of an old well that had been drilled on the site of the original building, and on general information as to the underground geology. The footings were redesigned after the contract was let, existing structures wrecked, and test borings made. The owner would not permit test boring prior to this time, fearing annoyance to the tenants in buildings on the site of the new building. The design of the cofferdam and shoring was revised after the rough excavation was made and underground conditions more clearly revealed. Steel sheet piling had been chosen for the cofferdam prior to the borings and excavation, as the result of information then available. Owing to the threatened steel shortage, this piling had been bought and was on hand.

At the south end of the sub-basement it was necessary to keep the cofferdam as close to the sub-basement wall as possible and to use the cofferdam as the outside form of the concrete wall to which the waterproof membrane was applied before building the sub-basement wall. The cramped space precluded the use of vertical or horizontal beams to support the sheeting within the area to which the membrane was to be applied. Vertical beams might have been used at the north end, but in that case the cofferdam would have been moved far enough north to permit the outside wall form to clear these beams. This would have required additional excavation and additional wall forms.

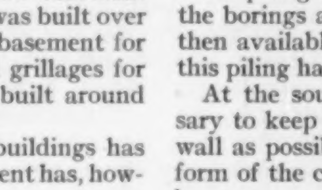


Fig. 1. Outline Plan of Existing Buildings and Addition

The power and telephone lines were supported on temporary trestles during construction and were then hung from the bottom of the alley slab and hidden by the suspended ceiling in the basement story.

The east wall and the floor slabs of the new building above the alley are supported on reinforced concrete beams cantilevered from the columns of the new building. This design was used to avoid overloading the old wall beams as well as to avoid an awkward connection between old and new concrete. In some sections the slabs of the new building rest on steel angles which are strapped

to the face of the spandrel beams of the old building. The new slab loads thus applied to these beams did not exceed the weight of the old brick walls which were removed. At the second floor the old wall beam extended above the slab. This beam was cut down to the top of the slab, the edge of the slab was notched out to receive the new slab, and a new concrete beam was cast under the edge of the old slab to support both new and old slabs. This beam was supported on reinforced concrete posts built against the existing columns. The eighth floor slab bears on the new brick wall built up on the old parapet. In another section the new and old slabs are supported on a continuous plate girder at each floor.

Since the alterations in the existing buildings and the new construction had to be coordinated and carried on with the smallest possible amount of interference with store operations, a complete schedule of operations was worked out and incorporated in the plans and specifications. This schedule was later revised as found desirable.

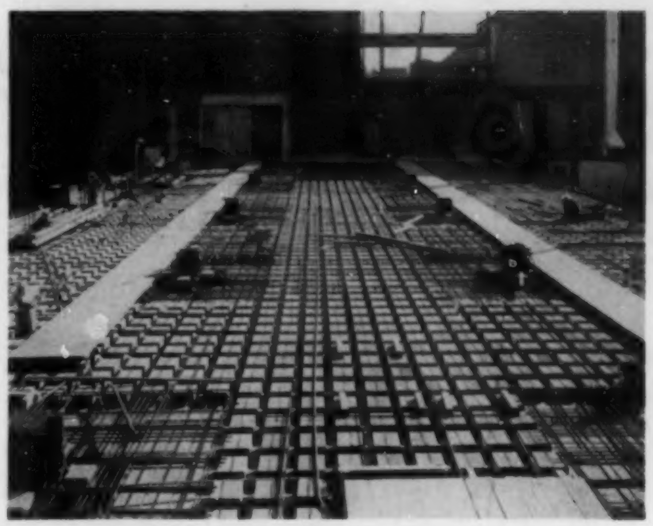
While alteration work was going on, the working areas were closed off by temporary partitions and usable store spaces protected. Owing to careful planning and execution, the work was completed without accident or undue inconvenience to the store customers and staff. Much credit is due the architects and the builder for the success of the undertaking.

CONTROL OF CONCRETE

For the work the engineer specified 2,500-lb concrete with the exception of columns and column footings. For these, 3,000-lb concrete was specified. The Pierce Testing Laboratories of Denver were employed to test the concrete. Nine cylinders were taken from each day's pour of 15 cu yd or more of each grade of concrete. Three cylinders of each set were to be broken at the age of 7 days, 28 days, and 60 days, respectively. Cylinder tests were to run 20% or more above the concrete strengths specified for the work. The 2,500-lb concrete was made with 517 lb of cement and 3,208 lb of aggregate per batch; the 3,000-lb concrete was made with 564 lb of cement and 3,155 lb of aggregate per batch.

The average slump for the 2,500-lb concrete was 5.3 in., while for the 3,000-lb concrete it was 5.6 in. In all cases the cylinders tested showed that the concrete exceeded design strengths. The cylinder strength followed the slump fairly well—low slump for high strength and high slump for low strength. The concrete was mixed at a central mixing plant and hauled to the job in trucks equipped with revolving drums and agitators.

The wood forms for the concrete work were of the usual type employed in reinforced concrete buildings—that is, wood sheeting for the deck supported on wood joists, and stringers and posts supported from the slab below. The specifications permitted removal of slab forms in two weeks after pouring of concrete under the most favorable conditions, providing sub-centering was placed under the slab as the forms were removed, this sub-centering to consist of posts spaced not more than 10 ft on centers both ways. The sub-centering was required to remain under each slab for 43 days, or until there were two well-cured slabs in place above the slab supported by the sub-centering. As the owner was anxious to get into the basement at the earliest possible date, the forms supporting the first floor were removed in about four weeks, in January. The concrete had been kept warm. Deflections were measured after the forms were out and the maximum deflection found in the 25-ft spans was about $^1/_8$ in. at mid-span, which was considered satisfactory.



View at Fourth Floor Level Before Concreting
Steel Girders for Support of Floors at Line of Old Bearing Wall (Removed) Appear at Rear

The structural design adopted for the new building has a number of practical advantages. By using steel for the interior columns only, and reinforced concrete for the columns and beams in the walls and around openings, most of the desirable features of a steel-frame building were secured with a minimum amount of steel and at minimum cost. Floor space was saved, flexibility for future alterations was preserved, and complicated connections between structural steel and reinforced concrete members were avoided. The use of flat slabs without drop panels reduced the form work to the simplest and cheapest possible and saved height, since the ventilating ducts, sprinkler pipes, and other equipment could be run at will on the flat ceilings without encountering obstructions. Four openings through the slabs, one on each face of the interior columns, are located between the arms of the steel grillages to provide for small ducts and pipes in the most favorable locations without interfering with the structural framing.

Fisher, Fisher and Hubbell of Denver were the architects; Platt Rogers, Inc., of Pueblo, Colo., was the builder, and Walter H. Wheeler, M. Am. Soc. C.E., of Minneapolis, who holds the patents on this system of framing, was the structural engineer.

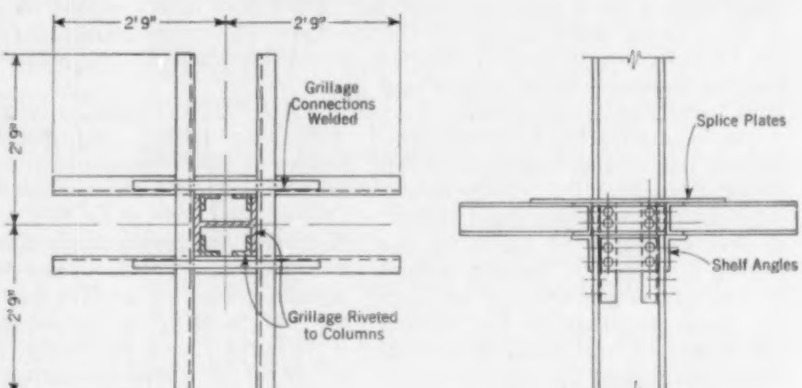


Fig. 2. Steel Grillage for Connecting Reinforced Concrete and Steel Columns

Roof Trusses with Span of 105 Ft, with Chord Extension to Avoid Gutters Between Trusses

Fabrication of Laminated Timber Members

Principles Employed in Design and Manufacture of Built-Up Units

By Verne Ketchum, M. Am. Soc. C.E.
Chief Engineer, Timber Structures, Inc., Portland, Ore.

USE of laminated timber in construction has increased steadily during the last few years. Especially during 1942, with the shortage of structural steel, the rate of increase has been greatly accelerated. Although lumber in various forms has to a large extent taken the place of steel for trusses and building frames, even in steel shop plants, the design and manufacture of laminated members and structures is subject to daily developments and improvements, and many new designs and details will be tested and used. However, some general information on fabrication processes has been established and can be given.

The basic principle in this type of construction is the combination of lumber, adhesives, and other materials to secure a structurally adequate product at a low price. It is not the aim to produce the most excellent structure that can be made, as that would entail a waste of materials, plant, and man power. The aim is rather to secure reasonable strength by the most economical means.

For instance, where joints in the laminations are outside the section of maximum stress, butt joints are generally used because, though not the strongest type of joint, they are sufficiently strong in this position. It is a waste of lumber, glue, labor, and plant to furnish scarf joints which give 100% strength when this full strength is not required.

Laminated construction using dry lumber has the distinct advantage of producing a member that will not check, warp, or distort after it has been put in place. The lumber is dried in small sizes, providing a better member in a much shorter time. Also, laminated members can have their sizes increased at the critical sections without increasing the size of the entire piece. With this type of construction, curved, cambered, or tapered members, which are pleasing to the eye, can be economically molded or shaped to the design size. These have been used extensively for curved and straight chords in trusses, for two-hinged and three-hinged arches, and for beams and columns.

It is now possible to construct beams of 70-ft span, wood trusses 200 ft long, and wood arches 200 ft or more in span, using glued laminated construction. Columns can be built to take care of combined vertical loads and bending stresses and can be provided with corbels or enlarged ends.

The bowstring has long been considered one of the most economical types of trusses. Prior to the extensive use of laminated construction, it was necessary to build up the curved top chord at the site using 1 or 2-in. pieces and spiking or bolting them together to the desired curvature. Overlapped segmental pieces which had the top side bandsawed to the desired curve were also used. The top chords of these trusses may now be built up using glued laminated construction, which gives the strength and appearance of a single solid piece.

Standard Lumber Sizes Used

Today nearly all laminated construction utilizes either Douglas fir, yellow pine, or hemlock. These species are the most plentiful of those suitable for such construction. The sizes of lumber used depend largely on whether the finished member is to be straight or curved. It is not practical to dry lumber for this purpose in thicknesses greater than the standard 2-in. commercial plank and this is the most economical thickness. Practical experience has shown that the thickness of a lamination should not be more than $^1/_{150}$ of the radius of curvature. Such pieces bend readily and do not build up high initial stresses. Lumber of almost any width and length can be used provided that the lateral and horizontal splices are properly staggered and jointed.

Lumber used in laminated construction may be Dense Select Structural or lower grades. A very large percentage at the present time is No. 1 common lumber with a slope of grain of 1 to 10, conforming to Paragraph 215 of

Table I. Values in Pounds per Square Inch, for No. 1 Common Douglas Fir According to Paragraph 215

	Solid—No Guarantee on Moisture Content	Laminated Dry Gluing Stock
Bending compression	1,200	1,400
Direct compression	1,000	1,100
Compression across grain	325	325
Horizontal shear	120	120
Modulus of elasticity	1,600,000	1,600,000

"Standard Grading and Dressing Rules" authorizing the use of a stress grade of 1,200 lb per sq in. This classification is for ordinary solid lumber cut green and air-dried under ordinary conditions.

The Douglas Fir Use Book contains the following statement: "In dimension sizes 4 in. and less in thickness, the development of defects during seasoning does not offset the increase in strength from drying as much as in larger sizes, and in these sizes used in dry locations, working stresses in extreme fiber in bending and compression parallel to grain are increased proportionately from equal grades of larger timbers."

This condition applies to practically all laminated construction since the requirement here is for small sizes of dry lumber. It would seem therefore that the use of the next higher stress grade or an increase to 1,400 lb per sq in. for laminated lumber under Paragraph 215 would be fully justified. The values given in Table I are those used and recommended by Timber Structures, Inc., of Portland, Ore.

WOODEN beams with spans as great as 70 ft, and wooden trusses as long as 200 ft are now possible through the use of glued laminated construction. One of the pioneers in this field, Mr. Ketchum, has promoted the development of commercial procedures that permit the economical use of smaller lumber sizes for the building of larger structures. This paper was originally presented before the Structural Division at the Fall Meeting of the Society, held jointly with the Engineering Institute of Canada in Niagara Falls, Canada.

We recommend that the values for other stress grades be increased accordingly. On Government work, specifications allowing much higher stresses for the duration of the war emergency are now being used. Also, some manufacturers use higher stresses, basing their authority on tables given in *The Glued Laminated Wooden Arch*, by T. R. C. Wilson, (U.S. Dept. of Agric., Tech. Bul. 691, 1939).

For wood used in casein laminated construction, the moisture content may be from 10 to 20%, and no close control of this content is necessary to produce good work. A moisture content from 10 to 15% is ordinarily the most suitable. The moisture content of the lumber should be close to what it will attain in the actual structure to avoid a tendency for the glue joint to work during the seasoning process. It has been found that wood under cover in various parts of the United States will under ordinary conditions eventually reach a moisture content of from 8 to 15%. Timber attains its maximum expansion at a moisture content of 28 to 30%, and a greater content does not change the shape or size.

Two general types of glue are used in ordinary laminated construction—waterproof resin glue and water-resistant casein glue. The resin glue, while being as cheap per pound as the casein, and requiring less glue per unit of area, has other disadvantages which have cut down its use. It requires an operation temperature of over 70 F, a higher finish than is found on commercial lumber, more care in spreading, higher pressures, and much more care in all other operations of manufacture. These requirements restrict resin gluing to work done by experts in temperature-controlled factories and prohibit its use at building sites.

Casein glue is now used almost entirely for ordinary construction. It is sold in powder form, usually in barrels, and must be stored in a dry place. One pound of the powder is usually mixed with two pounds of cold water to form from $1^1/_2$ to 2 quarts of glue mixture, which will cover about 35 sq ft of surface. Small gluing operations can be done with a standard 12-quart pail but large ones require a mechanical mixer. In small operations the glue may be applied to the lumber using a 3-in. brush or larger, made of stiff vegetable fibers which will withstand the alkaline action of the glue and retain sufficient stiffness for efficient spreading. On large operations it is almost necessary to have a mechanical spreader. It will also be necessary to have a number of strong clamps for applying pressure. A sufficient number of clamps will have to be used to allow them to remain on the pieces until the glue has properly set.

Mixing of casein glue is usually done in a large tank by mechanical means and should be under the control of one man only per shift. The glue powder should be added slowly to the water and mixed for some 3 to 5 minutes until the mass thickens. The mixer should then be stopped and the mass allowed to rest for 15 minutes. After this it should be again mixed for 2 to 3 min until it smooths out like heavy cream, ready for use.

Casein glue remains liquid and usable for a period of 6 to 8 hours at 70 F, and 4 to 6 hours at 90 F, but it gradually thickens into a rubbery mass which must be discarded. Therefore only enough should be mixed at one time for one working shift.

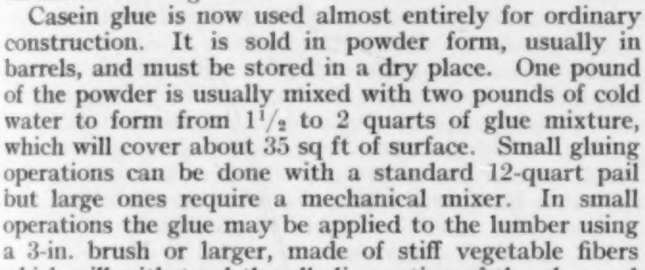


Fig. 1. Four Types of Joints for Laminated Members

When Many Similar Pieces Are Required, Pattern Assures Exact Measurements

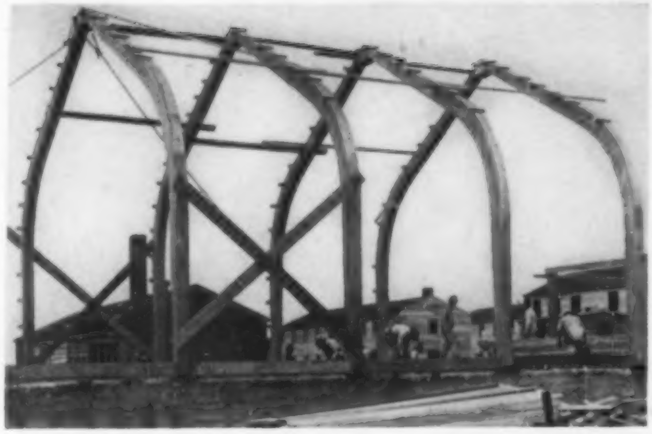
MECHANICAL APPLICATION OF GLUE

Glue is spread on the lumber with one of the standard types of spreaders which have been in use in various mill working plants for years. The spreader consists of sets of motor-driven rolls which revolve in a tank of glue and apply the glue to the board as it passes between the rolls. The rolls, being corrugated and under light pressure, apply a thin film to one or both sides of the board, as required. Depending on assembly time, moisture content of wood, and working temperature, sufficient glue should be applied so that the film will be moist when the pressure is applied. An ordinary lumber carrier can be used to move up the raw materials and to take away the finished product.

The working temperature for casein gluing may be anywhere above 50 F, either for indoor or outdoor work. The glue and lumber should be about the same temperature, and the water should be between 60 and 75 F.

After the glue has been applied and the lamination put in place, it is necessary to apply pressure to the member. This may be done by either of two methods. The first consists of driving nails long enough to extend through at least two full laminations. Sufficient nails should be used so that for each 8 sq in. of glued joint, there is at least one nail passing through a lamination on each side of the joint. For example, when laminating boards 2 in. thick, there should be one 20d nail head for each 8 sq in., or one 60d nail head for each 16 sq in. The other method of applying pressure consists of the use of standard clamps, which may consist of a commercial type of C-clamp or a homemade clamp using angles and bolts. Where laminated work is manufactured in a shop, the usual practice is to use nails only to hold down the ends of pieces, and to employ clamps for all the rest of the work. At the building site, where clamping equipment is not often available, nails are used entirely, as this method lends itself readily to use by inexperienced workmen with meager equipment. Practice has shown that it is better to use clamps throughout, even on the ends of pieces, than to use nails. It is the opinion of experienced manufacturers that the nailing method is inadequate to develop the pressures necessary for good work.

The pressure on glued joints should range from not less than 100 lb per sq in. to not more than 200, and should be applied by the use of jacks, clamps, or other equipment. Pressure should be applied within 20 minutes after the glue is spread on the lumber if it is applied



LAMINATED ARCHES PROVIDE A SIMPLE BUT STURDY FRAME FOR AN ARMY CAMP CHAPEL

to both faces meeting at a joint. If the glue is applied to one face only, the pressure should be applied within 15 minutes and should be maintained for at least 12 hours after the addition of the last lamination. As a general rule, the pressure should remain on the finished piece from 6 to 12 hours, depending on the moisture content of the wood and the temperature of the operation.

SEVERAL TYPES OF JOINTS USED

Scarfed joints may be formed in several ways, either by using a straight tapered bevel for both ends of the jointed members or by using various combinations of daps and bevels. Tests made by some authorities have indicated that a scarf with a straight bevel from 1:8 to 1:15, depending on the kind of wood used, will produce a full-strength scarf. It is recommended that a standard of 1:12 be adopted. Four types of joints are shown in Fig. 1.

The location of scarf joints in compression members is not very important, and providing the two ends are in bearing no loss in strength results. A good bearing between butt joints, however, is very hard to obtain. For members in tension, such as the bottom chords of trusses or the tension side of beams, either the laminations must be scarfed and glued to full strength, or the loss of strength in the lamination must be taken into account in the design.

It is apparent that the laminations of beams which are spliced in areas of no tension can be butt-jointed without loss of design strength. Similarly, in areas of small tension, some laminations can be butt-jointed. In areas of high or full tension stress, however, lamination splices should be scarfed for full design strength. By careful arrangement, it would seem that in most cases all laminations could be butt-jointed and such joints located outside the areas of high tension. While the locations mentioned are more or less arbitrary, it should be recalled that nearly all beams are designed by arbitrary methods, and lamination splices may be considered in the same way.

A consideration of the distribution of stress through a beam will show that a lamination near the quarter point of the depth of the beam has a working value of only about $^1/_3$ that of a lamination at the top of the beam, and a lamination at the center has practically no working value in tension or compression at all. It is thus apparent that a lamination in the middle of the beam may be composed of lumber having a lower stress grade, or may be butt-jointed with a relatively small loss of strength to the beam.

Since the maximum bending moment in a beam under static load occurs at one point only, the full design strength is required only at that point. In a beam of uniform section there is a reserve of strength in all other parts. Speaking now only of bending moments, we find that the full strength of a lamination in tension is required in only one lamination at only one point, and that is the extreme lamination on the tension side at the point of maximum bending moment. The reserve of strength in the remainder of the beam may be taken into account when considering splices and the stress grade of lumber to be used. Of course the stress grade of the timber will also have to be considered for the lamination under extreme compression at the point of maximum bending moment.

Authorities recommend that unscarfed joints be not closer together longitudinally than 40 times the thickness of the lamination so that there will be sufficient length for the proper transfer of the stress around the joint. It is also recommended that scarfed joints be placed not closer together than 25 times the thickness. Wherever possible, the outer lamination should be in one piece, but if not, at least it should extend in one piece across the section of maximum stress, as it is very difficult for the full stresses in the outer lamination to be transferred around a splice. All joints in curved members should be scarfed, as otherwise it is almost impossible to hold the jointed ends in position to form a satisfactory member. Some manufacturers scarf-splice all laminations in advance of assembly. First, the ends of the boards are scarfed and glued to form a lamination the full length of the member. When dry, this lamination is run through a planer to bring the scarfed joint to the same thickness as the remainder of the lamination. This planing is usually necessary as the ends of scarfed joints tend to "ride up" on each other, producing a thickening in the splice. Such a splice, if placed in the member without planing, would produce a bulge and adjoining opening. These laminations may then, of course, be treated the same as a full-length lamination without scarfs and can be assembled into the member to produce a very satisfactory although more costly unit.

Thus two methods are available—the pre-glued scarf lamination just described, and the method of placing all the laminations directly in the member and gluing all the boards and joints in one operation. The choice between these two methods may well be based on the

SHOP HANDLING KEPT AT A MINIMUM BY CAREFUL ARRANGEMENT OF EQUIPMENT

type, cost, and quality of the structure. Some successful manufacturers use the plain pre-glued and planed scarf-joint type throughout in preference to the butt or stepped scarf joint and maintain that they are able by this means to produce a better product at little or no additional cost.

Many designers have insisted that steel stitch bolts be placed at short intervals through glued laminated members to help hold them together. These bolts are apparently intended to bolster up the strength of the glue for fear it will fail after the structure has been put together. We believe that glued, laminated construction as built during the last few years has given such satisfactory results that this lack of faith in glue is entirely unwarranted.

It is very hard to hold the extreme end of a lamination to a predetermined curve, and curved members will tend to straighten out slightly when the clamps and forms are removed. This springback is not great, but may sometimes be $^1/_4$ or $^3/_8$ in. in a 40 or 50-ft truss chord. It seems to require some experience to forecast the amount of this springback, which can only be prevented by slightly distorting the curve, that is, by slightly accentuating it at the ends, from a point 3 or 4 ft back.

PREPARATION OF LUMBER FOR GLUING

All surfaces to be joined by gluing should be finished or machined; rough lumber should not be used. With casein glue, the ordinary finish such as is found on commercial 2-by-4's and 2-by-6's is satisfactory. The lumber to be used should be free of grease, dust, and dirt. To produce a good finish on the assembled member, exposed surfaces may be planed or sanded. Such finishing may be done as soon as the glue has hardened. An ordinary floor sander has been used for this work. Where it is intended to plane or sand the finished top chord of trusses or other members, the changed dimension should be considered in the design and in the detailing of any adjoining connections. For example, a top chord built up out of 2-by-6's would have a lateral dimension of $5^1/_2$ in. assembled, but after planing it would be cut down to approximately $5^1/_8$ in.

From experience to date, it seems safe to assume that casein-glued laminated construction will last as long as solid wooden members of any but the more durable species or treated material. The longest experience for glued prefabricated construction in the United States is about six years, and 30 years for built-in-place structures. The characteristics of casein glue render it unsuited for use in members in contact with damp earth or where the moisture content of the wood may repeatedly exceed 20%. Properly made glued joints on all woods commercially used for construction framing have a shear strength of 3,000 lb per sq in. This means that under extreme strain breakage would be in the wood rather than in the glued joint. Test pieces used by the glue manufacturers must be made of hard maple in order to secure any breakage in the joint.

Fireproofing treatments consist of impregnating the wood with various salts and compounds under pressure in sealed cylinders. During the treatment the moisture content is increased to between 60 and 75% under a pressure of 100 to 160 lb, and the temperature is 125 to 175 F. Glue manufacturers claim that casein-glue joints will maintain 100% joint value during any known fireproof treatment but that casein glue cannot be applied to lumber that has previously been fireproofed. Laminated members using resin glue will not stand up under fireproof treatment, but resin glue can be applied to lumber that has previously been fireproofed.

Glued-up laminated members using resin glue cannot later be treated by the Wolmanizing process of preservative treatment, but finished members using casein glue can later be treated by this process. Casein glue cannot be used on laminations that have been treated by the Wolmanizing process, but resin glue can be. Laminated built-up members can receive preservative treatments using a creosote base, but laminations that have been treated with a creosote material cannot be later glued either by resin or by casein glue.

At present, laminated construction is somewhat more costly than solid construction. Quotations for some recent jobs would indicate that the construction costs of laminated material delivered to the job were about 35%

BOWSTRING ARCH WITH EXTENSION FOR FLAT-TOP ROOF
Note Laminated Arch Rib

higher, per thousand board-feet, than those for solid construction. The laminated construction gives a superior product and often this higher cost is justified. Also, laminated construction often permits the construction of larger structures and longer spans than would otherwise be feasible. Connecting hardware, ironwork, assembly, erection, engineering, and general overhead are the same for both types of construction.

Where members are glued up at the site, they may be finished to any size which can be erected by the available equipment. Where they are built at a shop, at a distance from the site, splices must be used so that the pieces can be transported. It is usually not practical to transport pieces larger than 8 by 40 ft on railroad cars, and highways have overhead clearances and legal restrictions that must be considered.

Laminated construction requires the very minimum of bolts, connectors, washers, and other steel items, and often avoids the use of steel entirely except for anchorage details. While laminated construction is relatively new in this country, the design follows old established principles, and the proper manufacture can be easily and quickly learned by men experienced in other lines of building construction. Both laboratory and field tests give conclusive proof of the usefulness and durability of this type of construction, and conservative owners and engineers should not hesitate to use it.

The accompanying photographs show typical laminated members and illustrate steps in their fabrication. Further progress in glue manufacture, and the development and simplification of fabrication processes, are continually improving this product and reducing its costs.

Shoreline Erosion at La Jolla, Calif.

Special Instruments Developed in Study of Factors Responsible for Slow Recession of Coast

By FRANCIS P. SHEPARD
UNIVERSITY OF CALIFORNIA, SAN DIEGO, CALIF.

MODERATELY resistant rock formations and the relative infrequency of severe storms along the coast of Southern California are the factors accounting for the slow rate of recession of the sea cliffs at La Jolla. Records of weather conditions, currents, and movements of beach materials over a period of years have assisted greatly in a determination of the factors conducive to rapid erosion. Dr. Shepard contributes this paper, originally presented before the San Diego Section, as a result of his work with the Scripps Institution of Oceanography, La Jolla, Calif.

AN occasional landslide or collapse of a sea arch has led some residents of La Jolla and other coastal towns of Southern California to believe that the rock cliffs are retreating at an alarming rate. However, examination of a large number of photographs taken from 20 to 45 years ago has shown that there is almost no indication of important wave erosion during that period. Most of the changes that have occurred might be expected as the result of the weathering and erosion of these sea cliffs by rain storms. In many places projecting concretionary knobs on the cliffs make identification very certain. Few of these knobs have been removed.

Photographs by Dr. U. S. Grant IV and the writer, taken along other portions of the coast of Southern California indicate, for the most part, the same absence of erosion of consolidated formations. It is impossible to say whether the absence of recent erosion of these rocky sea cliffs is due to the failure of any major storm to strike them in recent years, but this seems a reasonable hypothesis. The sea cliffs may have been the work of previous storms of much greater intensity. Given great periods of time, the sea cliffs of Southern California could have been cut, even at the present rate of erosion, but all evidence indicates that this coast has not been stable for a long enough period to produce these cliffs at present rates of recession.

As for the sea cliffs cut from soft formations of recent age, they are much less stable. In all locations where such deposits are unprotected, erosion is observed to be progressing at a comparatively rapid rate. This erosion is ordinarily confined to the stormy winter and spring months, when the beach berm has been cut away leaving a steep slope at the base of the cliffs. In some cases the beach sand is entirely removed, exposing the underlying formations. After the removal of the sand berm, the cliffs may recede several feet in the course of one stormy season. If a hurricane like that which hit the New England coast in the fall of 1938 should attack the Southern California shore, erosion of a score or more feet could be anticipated in the soft formations, and it is likely that important retreats would also take place along the rocky cliffs.

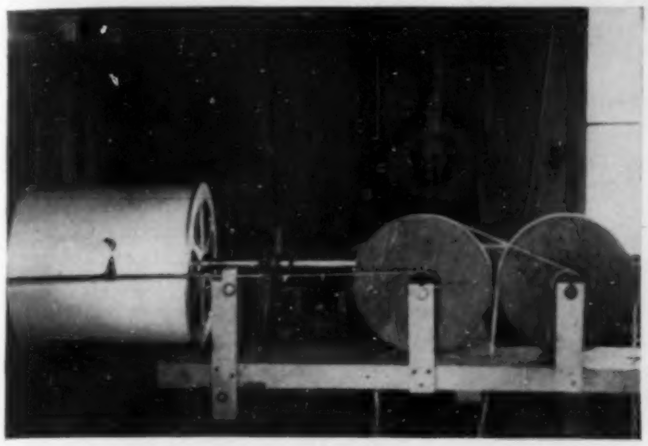
In a study of the factors contributing to the shoreline erosion in this area, observations of weather, waves, current, and other physical variables were begun at La Jolla in 1934. Since that time many thousands of observations have been made of the level of the sand along the pier of the Scripps Institution of Oceanography at La Jolla, and along the mile of beach to the south of it. Since 1937 many of the reference points have been measured once a day. In conjunction with this work, the height

Above, Beach Sand at a High Level at the End of a Quiet Summer; Right, Rock Formations Exposed After Winter Storms

VARYING BEACH LEVELS AT THE SCRIPPS INSTITUTION, LA JOLLA, CALIF.

and period of the waves at the end of the pier have been observed daily on a wave-recording machine. Also, currents have been measured almost continuously for about 3 years on an electric current meter. Over all this period the tide-gage records of the Coast and Geodetic Survey and anemometer records have been obtained from the same pier.

In the daily investigation of the local beach, notes have been made relative to the gravel cover, the char-



Wave-Recording Machine Provides Daily Data at the Scripps Institution Pier

acter of the sand, and the abundance of shells and kelp. Sand samples have been obtained periodically from both the pier and the beach area and these have been analyzed for median diameter. For comparative purposes observations have also been made of the sand heights at Del Mar Pier to the north and Crystal Pier to the south. Occasional surveys have been taken to determine the general character of current circulation in La Jolla Bay. Finally, the rate of cliff erosion in the La Jolla area has been checked by measurement and by comparison with old photographs.

This work has been of a cooperative nature. Much of it has been carried on or directed by E. C. LaFond, who is also responsible, along with Carl Johnson, for designing the wave machine and the pier sounding machine used. Dr. Harald Sverdrup, director of the Scripps Institution of Oceanography, was co-designer with Ott Dahl of the electrical recording current meter and has made many helpful suggestions during the course of the investigations. Recently the study of the wave records has been carried on principally by Dr. W. F. Wohnus. Extensive records have also been collected by Paul Williams. Various WPA projects have contributed to the gathering of records and the compilation of data. This brief paper is thus a report of the undertakings of various observers at the Scripps Institution, of whom the writer has been one.

INSTRUMENTS EMPLOYED IN THE INVESTIGATION

Some of the equipment used in these studies was designed especially for this work, and so far as the writer knows, has not been used elsewhere. It may be of interest to include brief descriptions of these instruments and their operation.

The wave-recording machine is operated on the end of the Scripps pier about 900 ft from shore, at a point that is almost always outside the breaker zone. By means of guide wires anchored to the ocean bottom, a float is lowered from the pier to the surface of the ocean and the up-and-down movement of this float in the waves is recorded at reduced scale on a revolving drum, shown in a photograph. This instrument is set

Float Used with the Wave-Recording Machine

in motion for about 15 minutes every day. It records the size of the waves and the periods between them, also the irregularity of the wave surface. These various characteristics are all important in connection with the eroding power of the waves.

Also located at the end of the pier is the Dahl-Sverdrup current meter, which operates electrically, making a continuous record of the direction and speed of the current moving along the coast, without, however, recording the offshore or onshore components of this current. This continuous record has shown that erroneous interpretations may result from occasional current readings. Although the currents are predominantly southerly in direction, north-moving currents are very common. The latter are observed almost every day, and may even predominate over the southerly currents for considerable periods of time. A study of these current records has shown that there is a direct relation between the currents and the beach erosion.

The sand-measuring machine is placed on the railing of the Scripps pier and rolled along it the length of the pier. Measurements are made at stations marked every 20 ft on both sides of the pier. The distance from the railing to the sand is read by the relation of markers on the wire to a yardstick along the top of the machine. By this means changes of as little as one-tenth of a foot are recorded, but changes of as much as several feet have been found during a 24-hour interval. The largest daily changes are most commonly excavations, but large fills occur during some of these short intervals.

Sand measurements along the beach south of the Institution pier require no instruments other than a measuring rod. A number of marks have been placed along sea walls and other structures usually reached by the waves at high tide. The height of these marks above the sand level is recorded each day. Other points out on the open beach are measured by means of ranges giving accurately located reference points, which are used to tell the height of the sand.

A fact that has been well-established by this work is that sand is carried seaward away from the beach during the stormy season of the winter and back onto the beach during the calm weather of summer. During some periods of large waves, the sand has been cut away from all 15 of the beach stations and along almost the entire length of the pier. When the waves were small, the sand was seen to build up onto the beach along almost its entire length. A continued period of such smooth seas causes the growth of a flat-topped berm along a beach where previously there had been a continuous outward slope of sand. As evidence that the sand does not move far from shore, it has been found that the sand level grows higher during the stormy months at the outer end of the Scripps pier. Also LaFond observed that shells

SCRIPPS INSTITUTION PIER, FROM WHICH MEASUREMENTS OF FACTORS CAUSING BEACH EROSION ARE MADE

found near shore migrate outward during the stormy season and back again during the calm weather. There is some movement of sand along the shore, but this appears to be less significant than the movement normal to the shore.

At points along the beach where sea walls have been built in front of sea cliffs, there is much more change in the sand level than where a sea wall borders a low stretch of coast. Also, the down cutting in winter is much less pronounced inside the head of a submarine canyon where the waves are less pronounced.

The amount of cutting in a particular storm is dependent on (1) the height of the waves, (2) the period of the waves, (3) the height attained by the highest tides of the storm period, and (4) the steepness of the beach preceding the storm. Maximum cutting is done by storms with the largest waves of longest period (between crests), during the highest tides, and where the beaches have the steepest slopes.

In some cases when there were large waves during periods of low tidal range, the beaches next to the sea walls were actually filled instead of cut. Also, the times of most extensive cutting have come so clearly at times when there were waves of long period that there can be little doubt regarding the importance of this wave characteristic. It was found that long-period waves come from winter storms much more intense than ordinarily develop along the coast of Southern California. A study of the weather maps, by Dr. Sverdruk and others, has shown that such waves originate in an area that is commonly from 600 to 2,000 miles out to sea off the California coast. Observations of these storms by ships may possibly be used in the future to predict the development of destructive waves along the coast.

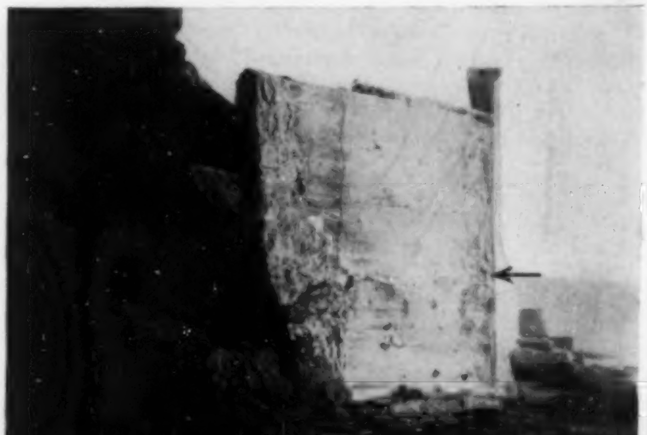
ACTION OF RIP CURRENTS

The effect of currents on beach erosion is manifested in several ways. A type of water movement out from the shore known as a "rip current," or more popularly as a "rip tide," is particularly important. The undermining of a sea wall south of the Scripps Institution was clearly related to a persistent rip current which could be seen carrying water seaward at the same point for many months. These rip currents produce small channels near shore and the water moves seaward in them at such a rate as to cause considerable danger to bathers. The term "undertow" used by bathers probably refers to rip currents. Where a rip current is causing erosion, any means which would shift its location would presumably put an end to the erosion. Probably the dumping of rubble into the inner channel, which might be exposed at low tide, would produce such a diversion.

The chief currents observed at the end of the Scripps pier move either to the south or to the north. Of these the south-moving currents are the more common and this is particularly true in winter. The currents are closely related to sea level, which is determined daily by averaging the hourly heights of the tide. A low sea level is accompanied by a southerly current, whereas a north-flowing current accompanies a high sea level.

There is, furthermore, a close relation between mean sea level (and currents) and the level of the sand, both on the beach and along the pier. The low sea levels accompany low sand, and the high sea levels high sand. Clearly the lowering of the sea level does not cause the cutting away of the sand, but the southerly current, which is no doubt caused by the low sea level, may have some effect in cutting the sand. An important cause of lowered sea level is the cooling of the water in winter, although it seems likely that certain storm conditions also have some bearing on this level. Lowering usually accompanies large waves even late in spring after the water has become considerably warmed above winter temperatures.

These conclusions, based on observational data, should prove of some value to engineers investigating problems of beach erosion. Some of the conclusions have no doubt already been anticipated by engineers in connection with their work, but other points may have been overlooked where there has been less opportunity to make observations over a considerable period.



EFFECT OF A RIP CURRENT ON A SEA WALL AT LA JOLLA, CALIF. Summer Level of Sand Shown by Arrow

Conservation of Critical Materials

Ingenuity in Savings and Substitutions—Condensed from Paper Before Niagara Falls Meeting

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ALL materials of construction are in some degree critical today. The degree of criticalness may depend upon location. Asphalt, of which ample amounts are being produced, is critical along the Atlantic seaboard, and virtually prohibited for war construction there, because of transportation difficulties. Cement is quite critical in a belt from Texas north to the Canadian border. Demands have exceeded production in this belt. Construction materials are all critical in the further sense that construction of any kind implies the use of transportation, which is critical, and the use of construction equipment, which contains highly critical alloy steels and is made by highly critical machine tools and skilled labor. In another sense, the use of even the most plentiful materials is critical in that the labor thus employed may be taken from work essential to winning the war.

Thus the conservation of critical material is not only a matter of substituting one material for another, but better still and more effective, it is the over-all reduction in the use of materials of whatever kind, achieved by eliminating all non-essential construction and by simplifying essential construction to the bare minimums which will serve the purpose for the time being and no more.

The Directive for Wartime Construction dated May 20, 1942, and issued over the joint signatures of the Chairman of the War Production Board, Mr. Donald Nelson, the Secretary of War, Mr. Stimson, and the Secretary of the Navy, Mr. Knox, admirably expresses this viewpoint. Allow me to quote from this directive, as follows:

"No project will be approved for construction unless it is found, by responsible authority, to meet the following criteria:

"*a.* It is essential for the war effort.

"*b.* Postponement of construction would be detrimental to the war effort.

"*c.* It is impractical to rent or convert existing facilities for the purpose.

"*d.* The construction will not result in duplication or unnecessary expansion of existing plants or facilities now under construction or about to be constructed.

"*e.* All possible economies have been made in the project, resulting in deletion of all non-essential items and parts.

"*f.* The structure of the project has been designed of the simplest type, just sufficient to meet minimum requirements.

"*g.* Sufficient labor, public utilities, transportation, raw materials, equipment, and the like are available to build and operate the plant, and the manufactured product can be used at once or stored if storage facilities exist to store it until needed.

"In general, all construction shall be of the cheapest, temporary character, with structural stability only sufficient to meet the needs of the service which the structure is intended to fulfill during the period of its contemplated war use. Ordinarily, wood-frame construction is preferable to reinforced concrete, and reinforced concrete is preferred to steel. However, the guiding principle should always be to utilize those materials which are most plentiful and which, in the ultimate analysis, will cause the least interference with the production of combat material and the utilization of transportation and power.

"Mechanical and electrical features shall be reduced to bare essentials. Air conditioning may only be used where manufacturing processes make its use essential, and not for the comfort or to increase the efficiency of personnel. Electrical systems shall be of the simplest design.

"Construction materials and end products, the use of which is prohibited by the ANMB directive 'List of Prohibitive Items for Construction Work,' dated April 1, 1942, and revisions thereof, shall not be specified, purchased or used except under special waiver issued by competent authority as provided for."

MATERIALS SUBSTITUTED AS OTHERS BECOME SCARCE

The Corps of Engineers necessarily has been concerned with the matter of critical materials from the outset of the war construction program. It will be recalled that once the critical material was aluminum. Other items rapidly became critical as the construction program grew. The use of a substitute material made the substitute critical in turn. The advancing realization of the true problem can be graphically seen within certain large projects, where at one end the buildings may be of steel frame construction, in the center of reinforced concrete, and at the other and last-constructed end, of wood.

On all the projects, a continuous study is given by the Corps of Engineers with a view to entire elimination of unessential items. A very fruitful field for the exercise of this sort of conservation has been in site planning. Expert application of planning technique has eliminated many miles of roads in camps and cantonments, similar lengths of sewer, water, and electric lines, great quantities of grading, and much highly critical rail. The same planning technique has been critically applied to road widths and surfacing. It has been an eye-opener to all concerned, I believe, to have these demonstrations of how effective planning of this character can be. It should be emphasized that these savings have been realized upon plans drawn by competent engineers, not necessarily skilled, however, in planning technique.

Existing structures are being converted to troop housing and to use as hospitals, thus eliminating the need for the equivalent new construction. The elimination of critical materials by simply ceasing to use them, or by substitution, has many aspects of interest to the structural engineer. In designs for the construction program, all alloy steel has been eliminated, except in machinery and equipment. Similarly zinc has been eliminated from designs for construction, though not from all equipment. Copper in designs, except for electrical purposes, has been eliminated, as has aluminum. Use of rubber, except for electrical insulation (and even there to a considerable extent) has been stopped. All the ferrous materials are critical, and every effort has been made to eliminate iron

in all its forms. However, in some degree, it has been necessary to use cast iron in place of steel, and steel in place of copper (as for water-heater tubes), that is, to use the less critical form in place of the more critical.

Use of structural steel has been greatly curtailed, and wood or masonry substituted for it. Wherever possible, as in warehouses, spans have been reduced to allow beam-and-girder construction and to reduce the requirement for long lengths and large sizes of lumber. In hangars up to 160-ft span, wood trusses are being used, and some use is being made of laminated glued arches. The use of such arches is limited, however, as the high-grade moisture-controlled lumber (1,800 stress grade) required in their construction is critical because of airplane needs, whereas the lumber for truss construction can be held to stress grades of 1,200 or less. The use of such designs in the construction program will have saved some 300,000 tons of structural steel in the last half of 1942.

It is interesting to note that the use of wood does not by any means eliminate the use of steel. To eliminate 11 to 12 lb of structural steel, designs in wood still require the use of 1 lb of bolts, nuts, connectors, and other hardware. Even this amount of steel is begrudged. It now requires an AA2 priority to obtain connectors.

Formerly the major requirements for nickel were in kitchen and cafeteria equipment, and for plating. Much of the kitchen equipment formerly of stainless steel is now being made of enameled sheet steel. Even hospital equipment has not been spared in this respect. Dental benches have been made with stone tops and enameled steel bins. Laboratory counters and chemistry tables are made with carbonized wood tops, with wood cases and stone or porcelain enameled steel sinks. Nurses' counters and benches are made with wood frames and cases, wood shelves, and lineoleum tops.

A major use of plating ordinarily is for plumbing fixtures. This plating has now been omitted entirely. Hot water storage tanks are now made of vitreous porcelain enameled steel, and of cement-lined steel. Laundry washers are made of wood instead of the Monel metal or chromium formerly specified.

Use of copper is so widespread in construction that it will be possible to enumerate only a few major substitutes. Substitutes for copper cap flashings are bituminous-saturated felt of 40-lb weight or laminated bituminous bonded paper. A membrane consisting of wire mesh imbedded under pressure between two layers of asphalted felt, a membrane consisting of 28-gage deformed sheet iron or steel coated on both sides with coal tar mastic, and a membrane of coal-tar-saturated cotton fabric are all used for spandrel and through wall flashings and miscellaneous exposed flashings.

The plastics that were advanced as substitutes for copper flashing are now themselves critical! Copper roofing has been eliminated entirely. In general, gutters have been eliminated entirely, but where considered essential are made of wood, painted iron, or steel. Where corrosive conditions are severe, galvanized iron and steel are allowed. Virtually all copper has been eliminated from hardware.

EXPANSION MEMBRANES OF PLASTIC

Lightning protection systems are using galvanized steel in lieu of copper. Copper window screens are out for the duration and in their stead, where screens are still considered absolutely essential, black enameled steel or plastic is used, and where severe corrosive conditions require, electro-galvanized steel. All copper water pipe has been eliminated and in its stead is used galvanized wrought iron, galvanized steel, cast iron, and plain black wrought iron when experience has proved the latter satisfactory in the locality. Even water stops in concrete dams and expansion bellows in concrete are formed of membranes consisting of wire mesh embedded under pressure between two layers of asphaltic felt, or are made of plastic membranes.

The reduction of requirements standards is best illustrated by cantonment construction, though the principle has been applied throughout the construction program. In the early stage of the program, the standard for troop housing was a two-story, sheeted, sided, and painted frame barracks with stud spacing of 2 ft, lavatory in the building, and forced warm-air heat. The standard now is a single-story barracks, 4-ft stud and rafter spacing, sheeted, felt covered, with $^1/_2$-in. insulation where needed. The barracks are heated by Cannon stoves. Lavatories are separate from the buildings. Wiring is exposed knob and tube, insulated with some substitute for rubber. The effect of this change has been to reduce the requirements for materials, lumber, steel, iron, copper, and rubber, per man housed, approximately 50% in each category.

SAFETY FACTORS REDUCED

A further method of conservation is by way of reduced safety factors. Where structural steel is used, design stresses have been increased to 24,000 lb per sq in., in accordance with the War Production Board Emergency Specifications. In reinforced concrete, flexural stresses in structural grade steels of 20,000 lb are required in design, and 24,000 lb for intermediate, rerolled, and axle grade steels. Bond and shear stresses have been increased 10%. These requirements have been in effect for some time, in accordance with Chapter XI of the Engineering Manual, issued by the Office of the Chief of Engineers, as has a requirement that definite stresses be allowed in unreinforced concrete produced and placed under controlled conditions.

In the present temporary type of construction, involving spans rarely greater than 30 ft, ungraded lumber is permitted a stress of 1,800 lb per sq in. in flexure. In larger trussed structures such as hangars, the design load is considered to be the full dead load plus three-quarters of the live load. This plan avoids changes of stress grades and resulting confusion in established grading practice.

In order to reduce the use of materials in water supply systems, the per capita design criterion for cantonments has been reduced from 100 to 70 gal per day, and fire-flow requirements have been greatly reduced. Sewerage systems have been reduced by similar means. Automatic sprinkler systems have been eliminated except in the wards of hospitals and in areas where great hazard of fire is combined with the probability of great loss should a fire occur. Sprinklers are not used in warehouses, even though these contain material of great value.

No magic method for conserving critical materials has been found, as can be judged from this recital. The methods used are the obvious ones that would occur to any engineer. These methods, like building a savings account, involve principally keeping everlastingly at the matter in small details as well as large. In a program of the magnitude of the one under consideration, details are multiplied many times, and are of great importance, but the matter of keeping after them is often irksome. The first requisite is to be thoroughly imbued with an understanding that conservation is necessary if we are to win this war. From that point on, the hard work, the sacrifices of comfort, convenience and efficiency, the risks, and the acceptance of short-lived construction are a natural and easy corollary.

New Foundations Provided for a Nineteenth Century Cathedral

By George F. Flay, Jr., Jun. M. Am. Soc. C.E., *and* D. B. McKinley

Construction Engineers, Spencer, White and Prentis, Inc., New York, N.Y.

YEARS ago subsurface investigations were not considered so important, even for major structures, as they are today. One case in point is St. Joseph's Cathedral in Hartford, Conn., begun almost seventy years ago. To arrest the subsequent settlement, which threatened collapse of the structure, a complete new foundation has been provided in the form of pre-tested underpinning. Extreme care, as described here by Messrs. Flay and McKinley, was taken to avoid disintegration of badly cracked masonry walls. The interesting methods used to secure stability were entirely successful.

ALTHOUGH underpinning has been defined in many ways, perhaps the simplest definition is the "strengthening of existing foundations." Usually the addition of powerful supports to the weaker portions of a foundation eliminates the "drag" on the remainder, and settlement ceases, even though only a small portion of the load has actually been picked up. In the case of St. Joseph's Cathedral, in Hartford, Conn., it was necessary to discount the existing foundation completely, and to provide new foundations for every ton of loading, a total of 31,000 tons. This is the largest single underpinning operation of which we have any record.

This beautiful structure, started in 1874, was finally completed, all but the two spires, in 1892. These spires, which would have added much to its architectural beauty, were omitted because it was recognized that the tower foundations could not sustain the additional load. In fact, before the tower had risen to any considerable height, settlements had already taken place throughout the structure. These settlements continued until, in the summer of 1937, the cumulative effect was evidenced by the falling of plaster moldings, and signs of imminent failure in certain of the interior arches, which had been strained and distorted. Owing to the absence of original records, the total settlements are not known. Differential settlements throughout the structure, however, amounted to as much as 14 in.

SAFETY OF STRUCTURE INVESTIGATED

The Diocesan Corporation, which had been paying heavy maintenance charges over a period of years, became alarmed and engaged the services of consulting engineers to report on the safety of the structure. The investigations carried on by this firm disclosed conditions involving extreme danger to the structure, and the immediate need for corrective measures. They found that the foundations consisted of stone footings bearing on clay of varying consistencies, the softest having the appearance, as one of the men described it, of toothpaste coming out of a tube. To such a stratum the footings were applying loads of 3 tons per sq ft under the walls and as much as 9 tons per sq ft under the apse piers. Between these piers, arranged in a semi-circle, the stone foundations were continuous, and the settlement of the piers had tilted the stones and actually pushed some of them up through the floor.

Borings disclosed that the clay stratum extended to an average depth of 40 ft below grade. As already stated, the clay varied in hardness in different parts of the premises, and also in color from gray to red. In various locations it carried thin layers of fine water-bearing sand. Fortunately, for about 5 ft below the foundations, the clay was dry and comparatively hard.

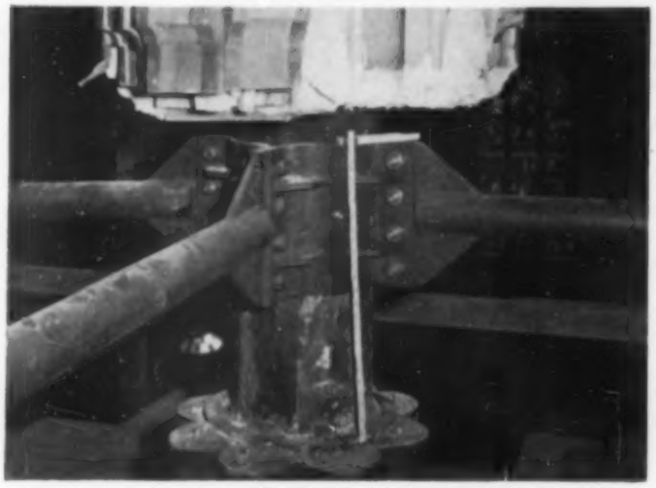
Below the clay, a layer of hardpan about 10 ft in thickness was in turn underlain by various layers of claypans and hardpans down to a depth of 100 ft, where rock was encountered. The engineers believed that the hardpan stratum would provide adequate foundations, and it was decided to go to this level, subject to tests to be made in the actual installation.

Investigations disclosed further that the foundation walls were in poor condition. Solid in appearance because of the large rectangular stones on the exterior, they were in reality a pile of loose stones, since the interior consisted of small stones and rock chips poorly bonded with an inferior mortar. Obviously such walls could not be relied upon to span over any distance, so that the underpinning must consist of a multiplicity of units providing, in reality, a continuous foundation.

The engineers had observed the successful use of pretest cylinders for the underpinning of buildings along the New York City subway routes and elsewhere, and selected this underpinning method. The use of caissons carried to hardpan directly below the foundations was also considered, but it was felt that the excavating of the caissons would involve serious danger to the structure. Further, owing to the condition of the masonry, the engineers considered it inadvisable to support the building at isolated points irrespective of the capacity of the supports. The pre-test system involved a minimum disturbance to the underlying soil, and the use of a greater number of smaller units imposed no additional stresses upon the masonry.

The design provided for 10, 12, 16, and 18-in. cylinders with working loads of 40, 50, 60, and 70 tons, respectively. All cylinders were to be jacked hydraulically to the hardpan stratum, and tested to a capacity of 50% greater than the working load. The transfer of the

Interior of St. Joseph's Cathedral
Columns in the Background Were Tied During Underpinning



PIPE TIES SUPPORTING INTERIOR COLUMNS
Marble Veneer Surrounds the Cast-Iron Core

loadings to the cylinders was to be accomplished by the so-called "pre-test" process. This method hydraulically maintains the test load on the cylinder during load transfer. The tops of the cylinders and the wedging struts were to be encased in concrete.

EFFECTS OF SETTLEMENT ON THE STRUCTURE

Careful examination of the structure disclosed that the greatest amount of differential settlement had taken place in the transepts and in the apse piers. The effect of settlement in the latter had pushed the four most northerly interior columns partly out of plumb. It was decided therefore that before any work could progress in this region these columns must be tied back firmly so that in case of further settlement lateral thrust against the columns would not cause collapse. The tying of the columns and the anchoring of the ties were accomplished by using 3-in. heavy pipe ties capable of a tensile load of 20 tons and a compressive thrust of 11 tons. The ties were anchored into the adjacent walls by means of 1-in. anchor bolts secured in steel plates embedded in concrete pockets in the wall. While installing these ties, it was hoped to put a nominal tensile load of about one ton into the ties to insure tightening of the connecting parts. Upon stressing the ties, it was found that the columns moved readily. It was felt, however, that pulling the columns back to plumb would strain the framing of the gallery supports, so it was decided to leave the columns firmly tied in their present position.

TYPICAL SECTION OF EXTERIOR WALLS
Loosely Bonded Stones Complicated Underpinning Problem

For the underpinning operations, the contractor assembled much special hydraulic apparatus suitable for this work. Instead of the usual hand pumps, water at pressures up to 7,000 lb per sq in. was supplied to the hydraulic rams by a 20-hp, 3-plunger, electric pump with two smaller duplex electric pumps as auxiliaries. To provide a continuous supply, two pneumatic hydraulic accumulators were used. One of these was placed approximately in the center of the premises, while the other was located close to the towers, whose weight concentrated a large proportion of the underpinning work at those points.

TWO DIESEL AIR COMPRESSORS USED

Air for cutting and drilling was supplied by two diesel air compressors with a combined capacity of 750 cu ft per min. This large capacity was made necessary by the great amount of cutting required. Owing to the poor condition of the walls previously referred to, considerable quantities of masonry had to be cut out and replaced with concrete so that the walls would be able to take the jacking loads. The compressors were also used to supply compressed air at 100-lb pressure to the accumulators, which carried "boosters" to raise the pressure to 200 lb per sq in. as required.

Approximately one-third of the cylinders were jacked on a batter in niches cut in the walls. This procedure not only provided lateral support but permitted the installation of the cylinders without excavating below the walls. The first units, installed on a batter of 1 horizontal to 7 vertical, showed a tendency to go down in a curve away from the footing. This was due to the compaction of the soil below the footing, and the situation was corrected by decreasing the batter to 1 in 10, and bolting the couplings to the casings so as to provide tensional strength.

The first cylinders were jacked open-ended, and the removal of the material from within the casings was slow and expensive. In the interest of speed and economy, the contractors developed a cast-iron shoe with a central portion of steel. This shoe was strong enough to penetrate the clay, and yet weak enough to break when the hardpan was encountered. The steel center was pulled out by a rope and the broken pieces of cast iron could be easily removed by the regular cleaning tools so that excavation could be carried 2 ft into the hardpan as specified. This shoe was generally successful, and was used until displacement of the clay by the closed-end casings began to cause uplift in the interior of the church. This uplift extended over considerable areas and reached a maximum of $^3/_4$ in., at which point it was felt that the installation of the closed-end cylinders should be discontinued. Obviously the open-ended cylinders caused a minimum of displacement of the clay, and no further uplift was noted.

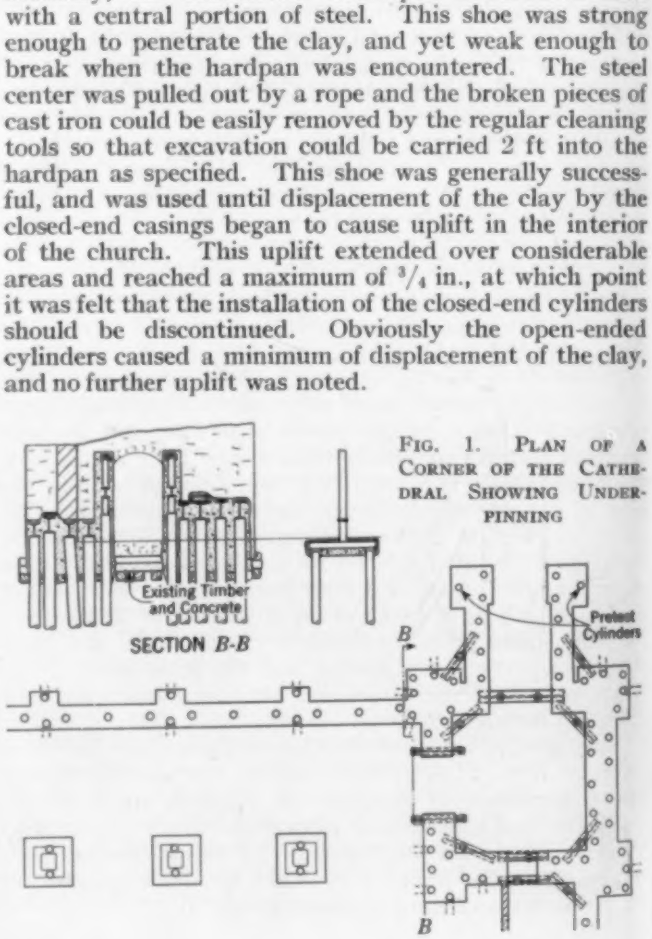


FIG. 1. PLAN OF A CORNER OF THE CATHEDRAL SHOWING UNDERPINNING

Cylinders installed vertically beneath the foundation were placed in pits sheeted with horizontal louver boards. Although not more than two days were required to complete any of the cylinders, the pressure of the clay was sufficient in many cases to cause a considerable bow in the louver boards.

The heaviest unit loads on the clay were found under the apse piers, whose foundations had already failed as previously described. The design called for four 18-in. cylinders to support each pier. Two opposing cylinders were driven on a batter, as already described, except that the jacking was started from a point well above the floor so as to throw the cylinders further away from the piers and avoid disturbance to the soil below the footings. The piers were also partially encased in reinforced concrete tied through the masonry and otherwise strengthened to permit the entire load to be carried temporarily on the two batter cylinders. With the loading so carried, the other two cylinders were jacked directly beneath the footing.

Batter Cylinders Were Installed for Support of the Apse Piers

Buttress Is Cut Into Masonry

The installation under the towers was the same as elsewhere except that there was some interference with a mat of timber and concrete which had evidently been placed in a crude attempt to secure greater foundation capacity. The additional depth of excavation required by these interferences caused minor difficulties with ground water. This water, while not excessive in quantity because of the type of material, was sufficient to further soften the ground and cause considerable inconvenience.

ENTIRE LOAD SUPPORTED PROGRESSIVELY

After the completion of the exterior walls and towers, in the manner shown in Fig. 1, it was decided to provide similar foundations for the more heavily loaded interior columns. Two cylinders were used under each granite column, except the four main columns, where four cylinders were provided. Before excavating below the column footings, a portion of the loading was transferred to pre-tested shores, placed on hydraulic jacks. As hydraulic pressure was applied to the jacks, the gage readings showed at all times the exact loading transmitted to the shores. The underpinning of these columns involved no difficulties except that care had to be used not to lift the columns in the jacking process, the greater part of the column loading being live load.

And so, progressively, the entire load of the structure was picked up 40, 50, 60, or 70 tons at a time. Throughout the work the whole structure was kept under continuous observation, line and level readings being taken daily. During the installation some additional settlement occurred, particularly in the early stages of the operation. Such settlements varied from nothing in some parts of the structure to a maximum of $^1/_2$ in.

The entire operation involved a total of 501 cylinders—49 ten-inch, 136 twelve-inch, 32 sixteen-inch, and 284 eighteen-inch. The total length of cylinders installed was approximately 20,000 lin ft, and the total tested load capacity provided was approximately 46,000 tons. A careful record was kept of the behavior of each cylinder under test in the hardpan, and samples of this material were recovered from practically all the cylinders. The stratum supporting the underpinning was found to be of uniformly good character, and we believe that the building is now founded on excellent material and is permanently secure with an ample factor of safety.

A more extensive history and description of this interesting work is contained in a paper on file for reference in the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

The underpinning work was designed and supervised by Lockwood Greene Engineers, Inc., represented in the field by E. B. Moebus and J. E. Goodrich. The Diocesan Corporation was represented by Bishop Maurice P. McAuliffe and Maginnis and Walsh architects. Spencer, White and Prentis, Inc., contractors for the underpinning, were represented in the field by the writers, Messrs. McKinley and Flay, engineers, and by Harry Armstrong and Mario Canale, superintendents.

Interior Column Loading Transferred to Shores During Installation of Underpinning

Typical Jacking Operation in the Tower Area

Note Section of the Old Footings Exposed

Renegotiation of War Contracts

Some Practical Applications in Relation to the Civil Engineer

By Harry W. Loving

Chief, Price Adjustment Section, Office of the Chief of Engineers, Washington, D.C.

It is certainly in line with public opinion in this country that no one be allowed to make an inordinate profit out of the war. This must be true therefore in the field of design and supervision of construction, with which civil engineers are so closely identified. The means by which the Congress has implemented this policy is by reinstituting the previously established principle of the renegotiation of war contracts.

What happens is that representatives of the War Department Price Adjustment Board sit down with the contractor, and generally discuss his over-all profit situation. In some instances renegotiation may be conducted on the basis of a separate or individual contract. If it appears that the profits are, or may be excessive, the matter is discussed with a view to an amicable adjustment, with a consequent reduction of profits to a point where reasonably minded men would not criticize them.

Obviously in a matter calling for good judgment, a sense of fair play, and a realization of the problems of management, the character of the Government's negotiators is of the highest importance. The men have been chosen with this in mind. When a contractor sits down with negotiators of the price adjustment boards he will find himself face to face with men who have but recently left their own businesses, and who are familiar with, and sympathetic towards, the complications which surround war contractors. These men are not theorists. Like the engineering executives they meet, they are believers in the American system of free enterprise, and are interested in its preservation.

It has been argued that renegotiation is not necessary on the ground that excess profits taxes would draw the money into the Treasury in any event. This reasoning is not sound for various reasons.

No tax formula would protect industry from charges of profiteering, no matter how large a part of the inordinate profits might be taken in taxes. And the American system of free enterprise cannot stand up under justified charges of profiteering. Taxes are too late also, as they get the money after it has been put unnecessarily in circulation, and has added its weight to the inflationary trend.

Control of costs is just as important as control of profits. Perhaps more so. Excessive costs are prima facie evidence that materials and man power are being wasted, and we cannot afford to waste either. Keeping prices close to costs is a good check on costs, and this can be accomplished by renegotiation, but not by taxes.

WHERE THE CIVIL ENGINEER ENTERS THE PICTURE

There appears to be considerable uncertainty among the civil engineers as to just how renegotiation of war contracts affects them. Broadly speaking the matter is a simple one. Civil engineers may be concerned in renegotiable war contracts either as professional men or as producers. That is professional engineers supply a brain service. Perhaps this is personal advice on a specific subject, or it may be on various features of the design of a project, or frequently on supervision of its layout. On the other hand, companies or individuals who actually turn out some tangible physical object, as a building or a highway, would be visualized as producers.

If a civil engineer, or a firm of such engineers, enters into a contract directly with the Army, Navy, Maritime Commission, or Treasury Department, then the law applies directly to such contracts. It should be remembered that the law specifically sets a downward limit and that unless the business amounts to $100,000 or more, no renegotiation can be called for. This sum may be in one contract, or may be the total of several.

In actual practice there have, of course, been many important contracts for engineering supervision and direction which have not amounted to $100,000. As the law stands, such contracts will not be examined, although there is nothing to prevent an engineer from returning a part of his fee if some set of circumstances has resulted in an unreasonably large net profit.

Any aggregate of new contracts or expansions of old contracts which total above $100,000 makes the firm liable for a review of its over-all profit position. In all such proceedings the Board will not examine individual contracts, but instead considers the earnings as a whole.

Basically, there is no difference in procedure in regard to renogotiation of various types of contracts, including the architect-engineer-manager type. In the matter of cost-plus-fixed-fee contracts, there might be a difference in the items that would have to be closely examined, but as far as general procedure is concerned, the operation would be the same.

SPECIAL FEATURES AFFECT CIVIL ENGINEERS

Obviously the problems encountered in reviewing the position of professional men differ considerably from those met in the case of a producer of goods. Rising volume usually leads to a larger net in manufacturing. In engineering work the reverse may be true, and in any case it cannot be assumed that the bigger the job, the bigger the engineer's profit. The War Department Price Adjustment Board is aware of these facts, and is prepared to give them due consideration in negotiations with civil engineers.

Another way in which engineers may have a part in renegotiable war contracts is when they also participate in the construction contracts. In such cases they become producers of material and as such they naturally will encounter renegotiation on any business exceeding $100,000.

Large engineering firms which may have a considerable number of renegotiable contracts may be approached regarding renegotiation by individual procurement officers of the various services. Once an over-all renegotiation has been instituted, all individual officers are called off, and the whole job can be accomplished in one transaction.

Any individual engineers, or engineering firms, having contracts that are renegotiable have a contingent liability on their books, which it is good business to remove. They can approach the War Department Price Adjustment Board in full confidence that renegotiation is not a punitive measure, and that it is administered sensibly and fairly, with only one end in view—the best interests of the nation at war. Inquiries should be addressed to the Board at Room 3D 614, Pentagon Building, Arlington, Va.

Effect of War-Induced Migration on Urban Communities

By Robert K. Lamb
Staff Director, House Committee Investigating National Defense Migration, Washington, D.C.

THE allocation of millions of dollars for war contracts in shipbuilding yards, airplane factories, and ammunition plants has drawn workers together in communities which cannot furnish adequate housing, transportation facilities, or other necessary services. The multiplied difficulties encountered in planning for the care of migrants, which has been the concern of the Tolan Committee, are here discussed by Mr. Lamb. He also brings up the serious problem of what to do with the vast army of uprooted defense workers when the war is over. His paper was presented before the City Planning Division at the Society's Minneapolis Meeting.

WHY migrate? During the depressed thirties the migrant could have answered that he was moving from an area of declining to one of expanding opportunity. This is still largely true today, in a period of war boom. There is, however, a certain difference. Previously most migrants moved towards they knew not what. The "push" factor was dominant. Today the "pull" factor is uppermost, even though there are still many declining communities from which migrants are being pushed out.

The problems of the migrants, as well as the problems of the communities to which they move and of those they have left, are the objects of investigation by the House Committee Investigating National Defense Migration, known to its friends as the Tolan Committee. There are few sources comparable to the hearings of this committee on this subject. The committee has given continued study and action both to a solution of pressing present problems and to the anticipation of the post-war demobilization of war industry and the armed forces.

It is possible to predict an enormous migration after the war, not only because of the magnitude of current mobilization of manpower for war production and the armed forces, but also because of the deep underlying trends of American life which may be expected to reassert themselves after the war. The population censuses show that urbanization is a steady trend, that population is moving towards the periphery of the country, that megalopolitanism is the order of the day, with the greatest growth in satellite cities around a decaying downtown metropolitan core.

POWERFUL CENTRALIZING FORCES

During the twenties, and even more during the thirties, we were beginning to lay the groundwork for decentralization and urbanization, by means of the auto-express highway and electrical grid systems, but powerful centralizing forces kept pushing us in the direction of megalopolis. Today the restriction of government contracts to a limited number of large war contractors is tending to perpetuate the previous trend.

One of the chief accompaniments of this trend is the growing rootlessness of our population. Smaller and smaller numbers of our people are natives of the place where they now reside; even in our centers of oldest settlement such as the Southeast, uprooting forces are vigorously at work. The industrial revolution has overtaken agriculture, especially during the last decade of depression, subsidized in some measure by government checks. Large-scale agriculture has come to dominate

Farm Security Administration

Thousands of Workers Have Migrated to War Plants
Change of Shifts at an Aircraft Factory

one crop after another, until today considerably less than one farmer out of ten produces half of all our farm output.

What is true of agriculture is also true of industry and trade. Not only is the largest part of our population removed from the class of proprietors of workshops and stores, but new additions to their ranks are constantly being recruited. The war program is deeply affecting both industry and trade so that more and more of our smaller communities, up to say 50,000 population, are threatened with a rapid decline as their workers move to centers of war production, their factories close for the duration, and their stores and homes become vacant. The consternation these communities feel is matched by that aroused in the communities which receive the influx of these same workers.

NUMBERS OF MIGRANTS ESTIMATED

There are no adequate nationwide figures on the migration of war workers. In a report of October 1941, it was estimated that 2,000,000 persons had moved directly to jobs in war industries or to reside with those who took such jobs. This does not include persons in services trades, non-defense industries, or agriculture. Since that time the increase in appropriations and especially in contracts let has undoubtedly raised the number of migrants. Continued construction work has also induced much migration not included in the estimate.

A better indication of increases in the population of certain cities where expansion has been greatest can be had from the migration studies carried out by the Division of Social Research of the Work Projects Administration. Howard W. Myers, testifying before the Tolan Committee in February 1942, reported that "our estimates show that approximately two and a quarter million persons, including about 1,000,000 workers living in cities of over 25,000 population, had moved to those cities after October 1, 1940. The over-all migrant rate for cities of over 25,000 population was 4.3%."

In a summary of the surveys, Mr. Myers predicted that "migration will grow even more rapidly during the coming months, stimulated by the marked intensification of the war effort, by the near absorption of the resident labor supply in certain 'hot' areas, and by rapidly growing priorities unemployment. The rubber

shortage will inevitably make commuting more difficult, so that cities which are now dependent on a large number of commuters must be prepared to house great numbers of migrants when large-scale commuting is no longer possible. During the first year of war, migration should exceed by a considerable margin the volume during the prewar period."

The survey went on to say that, on the whole, defense migration had been up to that date surprisingly successful, especially in view of the unguided nature of the movement. Moreover, occupational upgrading had been widespread. Certain groups had been less successful, notably women, workers over 45, and Negroes. Indeed, the large-scale migration of Negroes during the First World War has not been duplicated. Most of the rural migrants have come from villages; few are from agriculture. Few of the migrants have traveled long distances. In most centers the average distance is less than 125 miles. In half the cities the average age of all migrant workers is 29 years. As the Selective Service reaches into war industries, this predominance of young workers will set in motion further migration.

CONCENTRATION OF WAR PRODUCTION

The pattern of this migration is, of course, traceable to the distribution of war contracts. Concentration of contracts in a few centers of production induces migration to those centers. Certain factors further distort this pattern. In areas of expanding employment located within a large region of declining employment, migration toward the central area is occurring without reference to successful placement. Where discrimination is also present, an aggravated unemployment situation develops in a boom area. This was the case, for example, in one Mid-Western city in November 1941, as described in the statement submitted to the Tolan Committee by its mayor:

"This in-migration is wholly unnecessary from an employment standpoint. The labor forces of the area as at present constituted can meet all demands now in sight and no further migration will be necessary to supply employment needs. There are now approximately 43,000 persons who are unemployed, and in the defense work it is estimated that a total of about 37,000 additional will be needed. It is apparent then that the in-migration will swell the ranks of the unemployed and increase the burden of the relief agencies in the city and county. It would seem that this situation would deter in-migration, but that is not to be expected. News spreads throughout the rural districts and in other urban centers that migrants to the city are getting jobs; and the general publicity is that of 'boom-town' employment, and the general public believes that there is no more unemployment. . . .

"The solution would be further aided if the press would give wide publicity to the unemployment situation prevailing here and the futility of submarginal families migrating to this community in search for employment. It will also be helpful if we all work toward the avoidance of discriminating against citizens [of this city] because of race. There are several thousand colored workers who are qualified for employment in the defense industries, but are refused employment solely on account of their race. . . .

Farm Security Administration

TRADE INCREASES FOR FORTUNATELY LOCATED MERCHANTS
This Small Lunchroom Outside a Shipyard Now Feeds 200 Men a Day

"It would also help to stem the influx of outsiders seeking employment if employers and job seekers alike resorted more to state employment agencies where the seeker after employment could get real information as to the need of his services."

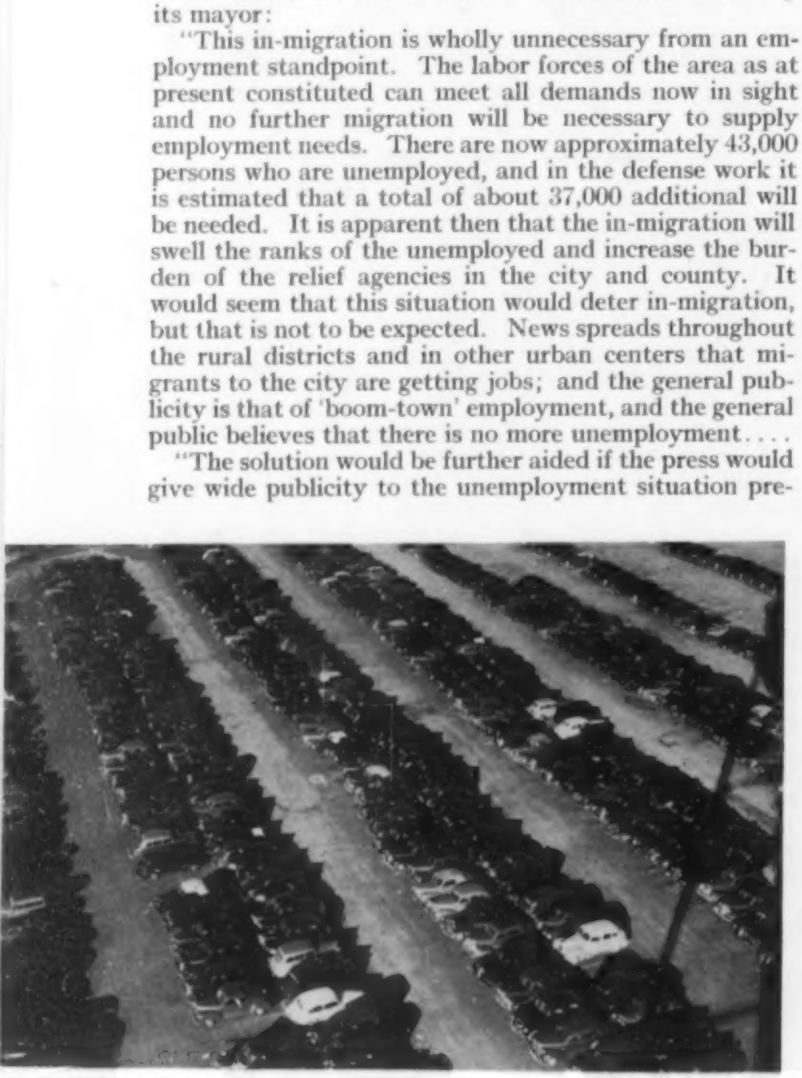
Another example of discrimination suggests that in the case of certain groups it is a carry-over from peacetime practices, but is aggravated by the development of shortages in other local labor supplies. Under these circumstances the demand by public officials that these workers be used becomes more intense and the resistance likewise mounts.

Also disturbing the orderly movement of workers to jobs is labor turnover, induced particularly by poor living conditions in overcrowded industrial centers. To date large sums have been expended by the federal government under the so-called Lanham Acts in order to provide increased facilities for housing, health, education, and recreation of war production workers. This series of appropriations has amounted to date to \$600,000,000. In spite of the absolute size of these appropriations, they are certainly inadequate when compared to the developing needs. Today, moreover, shortages of materials are making it more and more difficult to complete projects already appropriated for, to say nothing of possible future projects already needed.

A peculiar aspect of the expenditure of these sums by the federal government is the creation of federal "islands" which are sometimes tax exempt and sometimes required to make payments "in lieu of taxes." Even these payments "in lieu of taxes" are not always satisfactory to the community because of differences of opinion as to the services that need to be covered.

TRANSPORTATION NEEDS

For some time the problem of transportation and congested highways has complicated the operation of war production plants. Under the impact of rubber shortages and gasoline rationing this congestion may be expected to decline somewhat, whereas the planning of mass transportation of workers to war jobs is bound to



PRESENT TRAFFIC FACILITIES ARE INADEQUATE FOR WORKERS' TRANSPORTATION NEEDS
One of Three Parking Lots at an Aircraft Factory

Farm Security Administration

TRAILER COURTS HAVE BECOME HOME TO MANY WORKERS
Camp near a Southern Air Base

become increasingly important. An illustration of the conditions existing until very recently in an eastern state was presented to the Committee by its State Highway Commissioner:

"Undoubtedly the most impressive illustration of this unprecedented traffic congestion is to be found in the vicinity of the numerous defense industries. Before the national defense program got under way, the great majority of these plants operated on an 8-hour basis. Furthermore, many new industries specializing in war supplies have cropped up in the past year.

"Under the present drive to speed aid to the Allies and bolster our own forces, these industries have been forced to operate on a full 24-hour schedule, necessitating three 8-hour shifts for workers. This naturally means three times as many persons are working at plants which were in operation even before the war, plus the great influx of new workers in new war industries."

The control of transportation will determine the commuting areas, the numbers of workers available within a given radius, and the question of housing. With the increasing shortage of critical materials for construction, questions such as rent ceilings, the doubling up of workers, and the leaving behind of non-working members of migrant families all become pertinent.

FURTHER MIGRATION FORESEEN

Additional migration may be expected. The volume of this, however, will be contingent upon the manner in which our war production program is organized. Much depends upon the operation of the War Manpower Commission. Present evidence indicates that the Commission and its subsidiary, the U.S. Employment Service, will continue to play a secondary role in job placement unless and until they assume compulsory powers. This would not necessarily be the case if they operated more closely with the individual war contractor but there seems little likelihood of this development.

Consequently, we will either see a continuation of hiring at the gate and unguided job seeking, or the institution of compulsion, in which case more and more workers may be guided in the direction of a limited number of large contractors with the consequences that have been described. This limited number of large communities is going to have increasing difficulty in providing housing, health, education, and recreation facilities for additional hordes of workers. As the use of individual passenger cars declines, transportation will become an increasing problem and we may expect that the federal government will have to intervene to straighten out the tangle. Voluntary methods now being employed will not meet the situation.

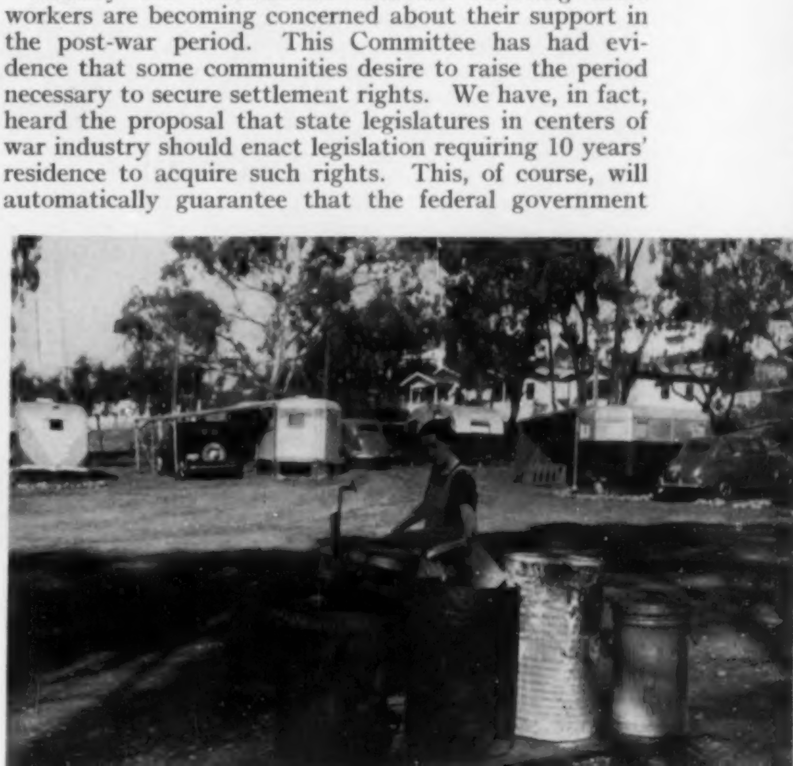
A PROBLEM OF SERIOUS PROPORTIONS

Some idea of the magnitude of the problem may be derived from the fact that we have today between 9 and 12 millions employed directly in war work. Some 3 millions of these must be recruited for the armed forces within the space of the next year, according to present expectations. Also, within that period, employment in war jobs is expected to increase to at least 20 million, and by the close of 1943 may even approach 25 million. The shift necessary from non-defense to defense employment will certainly not take care of the total expansion, and above all, these workers are not to be found locally in most centers of expanding war contracts. The size of the demand for migratory war workers may be gaged from these estimates. The total number of migrants will, of course, depend upon the opportunity for securing living quarters for dependents, and we may expect increasingly to see dependents left behind.

As to whether these workers who have migrated will remain in the cities to which they have gone, again much will depend upon whether they do or do not take their families with them, and upon what job opportunities will remain in the communities from which they have moved. In the last war, shipbuilding centers were hardest hit by the post-war slump. Other industries similarly affected included the heavy industries, mining and lumbering. These were the ones that had enjoyed the greatest expansion, and consequently experienced the greatest contraction. Undoubtedly, shipbuilding and aircraft construction will again far exceed levels that can be maintained in peacetime.

Similarly, government-owned munitions plants will shut down and their workers, usually now located in rural areas, will not find adequate support from peacetime industries in their vicinity. There is reason to believe that we will have as many as two million people working in aircraft plants and a similar number in shipbuilding before the war is over. It is hard to imagine that peace-time industries will support any such numbers of employees. This situation may be relieved somewhat by the fact that increasing numbers of these workers will be women, the majority of whom probably will prefer to return to domestic pursuits after the war is over.

Already the communities that are receiving these workers are becoming concerned about their support in the post-war period. This Committee has had evidence that some communities desire to raise the period necessary to secure settlement rights. We have, in fact, heard the proposal that state legislatures in centers of war industry should enact legislation requiring 10 years' residence to acquire such rights. This, of course, will automatically guarantee that the federal government



LACK OF SANITARY FACILITIES ENDANGERS THE HEALTH OF MIGRANTS
Rubbish Disposal at a California Trailer Camp

Farm Security Administration

Farm Security Administration

ONE-ROOM TENT HOUSES A CONSTRUCTION WORKER'S FAMILY IN CALIFORNIA

will have a staggering public assistance burden in any extended post-war depression.

It seems probable, however, that along with an increase in the burdens which these communities are acquiring there is a trend towards declining tax revenues. I believe we can foresee that the situation prevailing during the early thirties will recur, with larger and larger numbers of local communities and even state governments unable to carry the funded indebtedness required to support either the public facilities now being installed to keep pace with growing populations or the public welfare programs involved in this population increase. Certainly, whether these burdens can now be borne or not, there is good reason to believe that they will become unbearable at the close of the war.

DECLINING TAX REVENUES

Meanwhile we see that certain communities, such as the city of New York, already heavily burdened with debt on previously installed public facilities, and carrying a large annual cost for public services, are not being benefited by the war boom, but on the contrary are experiencing increasing unemployment and declining tax revenues from decreased business activity. These declines in many communities will continue throughout the war and may be expected in the years 1943 and 1944 to confront the federal government with the question whether subsidies may not be necessary to shore up the local financial structure. Even drastic economies in these communities may not be sufficient to keep up with declining revenues. Direct subsidies to supplement these revenues are certainly no substitute for the circulation of purchasing power and employment represented by war contracts. The time does not yet appear to be at hand, however, when these alternatives will be frankly faced.

One matter in which the Tolan Committee has been particularly interested is a proposal for a one-year-gaining and one-year-losing settlement law in connection with the passage of a general relief bill. It has even sometimes been suggested to this Committee that such a requirement be attached by amendment to the existing three categories of the Social Security Act. In any event, it seems that the passage of revised settlement legislation should be undertaken while the war is still going on and the numbers seeking public assistance are at a minimum. The alternative to the passage of such legislation appears to be the creation of an enormous army of stateless citizens.

These people will quickly exhaust their unemployment compensation benefits (which are quite meager in certain states). When these benefits are gone the prospects of early employment, particularly with the demobilization of an army of say 8 million men, can hardly be promising. They will not be eligible for local or state relief, and if no federal relief is in sight they will await passage of legislation establishing public works or work projects of some sort. Presumably there will not be sufficient work for all these people in such projects and in any event it has been customary in the past to discriminate against non-residents, so that they will be the last to receive such employment.

This is not a cheerful picture but it seems realistic. If we were to pass a one-year-gaining, one-year-losing settlement requirement, then all localities would have to accept these people as residents, and the responsibility for adjusting the burden involved would soon fall upon the Federal Government because of popular pressure from the states.

A considerable contribution can be made to the solution of post-war difficulties by the accumulation of a shelf of projects. These would provide public work to fill the gap that is sure to exist for some time, possibly even for a year or two, at the close of the war. It is my belief, also, that to secure adequate support for such proposals we should begin now to educate the residents of our communities to the potentialities of a good-sized works program for the post-war period. A considerable part of this work need not be completely subsidized from the public purse. For example, a well-planned housing program might well be partly privately financed. Indeed, if it could give investment to the funds of the great banks and insurance companies, it would go far towards achieving this purpose. One thing, however, is certain. Unless the public understands the need for public works of this sort we are not likely to get them, and certainly not on the scale required. Another thing is equally certain; each community must realize that it cannot shift the burden ahead by enacting local ordinances or state legislation but must become a participant in a national plan for dealing with the unemployment of war migrants as well as that of long-time residents.

Farm Security Administration

AN EARLY DEVELOPMENT OF THE SUDDEN EXPANSION IN WAR PRODUCTION

Flop House of 37 Beds Crowded with Workmen Sleeping in Shifts

"Flight Strips" for Military and Civilian Use

Program Being Carried Out by Public Roads Administration of the Federal Works Agency in Cooperation with State Highway Departments

By Fred E. Schnepfe, Assoc. M. Am. Soc. C.E.

Director, Flight Strips Division, Public Roads Administration, Washington, D.C.

The practicability of building numerous relatively inexpensive landing fields has been demonstrated by the operations of great numbers of military aircraft. Following the settlement of the present conflict, the great interest in civilian aviation will give rise to an expansion of air transport facilities which will find widely dispersed landing areas essential. Thus a dual purpose—military and civilian—is served by the "flight-strip" program of the Public Roads Administration of the Federal Works Agency. This article is taken from the paper presented by Mr. Schnepfe before the session of the Highway Division at the Society's Fall Meeting in Niagara Falls, Canada.

As the war has taught us, it is folly to concentrate a large number of aircraft on one airport. It is equally foolish to depend upon a few large airports in any defense area as enemy air action could quickly put these few out of commission. It is desirable to have not only a large number of airports but also a large number of "flight strips" upon which to base and disperse our military aircraft.

By means of flight strips, landing areas may be provided at many places where the cost of an airport would not be justified, in terms of money, materials, transportation, and man power. Although a "flight strip" has only one runway, it is believed that, by a careful study of the winds prevailing at any location, the runway can be so located as to be available for safe operation during the greater part of the time.

Although military considerations are naturally uppermost in our minds at the present time, some post-war considerations should also be mentioned. Post-war Americans will be in the air in ever-increasing numbers, and our business and social structure will place an increasing burden on air transportation. With the army program calling for the training of many thousands of fliers, immediately following the war there will be a very large number of people in the country who have learned to fly. Many of these will wish to travel by private plane rather than by automobile as has been the custom in the past. There can be little question that sufficient planes will be available. It is an important responsibility of the federal government to see that air transportation is not retarded through lack of ground facilities.

The volume of air mail is increasing at an accelerated rate and many forms of cargo are already transported by plane. There can be no doubt that following the close of the war the air transportation network will have to be enormously increased over the present system, with many new trunk lines and feeder routes.

The part that the flight-strip program is expected to play in the post-war plan of transportation may be summarized as follows:

1. Provide landing facilities for the civilian flier.
2. Provide basic landing facilities for small cities or groups of towns for air feeder and air cargo service.
3. Provide auxiliary landing facilities for all types of aircraft.

My earliest recollection of the idea of "flight strips" goes back to 1931, when I met Col. Stedman Shumway Hanks, who had already for some years been carrying on a campaign of education to promote their use. However, authorization for the actual construction of such strips by the Public Roads Administration of the Federal Works Agency was not given until the passage of the Defense Highway Act of 1941. Altogether two appropriations have been made, of 5 million dollars each.

In the Manual of Procedure for the flight-strips program, as prepared by the Flight Strips Division of the Public Roads Administration, a "flight strip" is defined as "an area of land with clear approaches located adjacent to a public highway for use as an auxiliary landing area for aircraft." While the flight strip serves the same purpose for take-off and landing as an airport, it does not have the various facilities found at an airport, such as terminal building, hangars, shops, gasoline storage, and lighting system. Therefore, the cost of a flight strip represents only a part of the cost of an airport. While a flight strip provides only one runway, those being built by the Public Roads Administration provide for long runways and approach areas of a greater width and flatter glide angle than can be found at most airports. Flight strips have the twofold purpose of providing facilities for military and civilian aircraft.

Site Selection and Layout

Site selection is of primary importance, and since every site has its limitations, thorough investigation and good judgment are necessary to evaluate its advantages and disadvantages. Investigation of suitable

Concrete Surfaced "Flight Strip" with Adjacent Service Highway

BITUMINOUS SURFACED RUNWAY FOR A FLIGHT STRIP

construction material on or near the site should be made for economy in first cost and subsequent maintenance. The fact that gravel, sand, or stone deposits are available at or near a proposed site may well influence the decision, provided that soil and aeronautical features are suitable.

Since a flight strip has only one runway, it is of particular importance that it be located in the direction of the prevailing winds. Investigations to determine the layout should include "wind-rose" charts and information on fog and smoke conditions affecting general visibility in the vicinity. Sites must be selected where nearby obstructions are not of sufficient height to create hazards, or where provision can be made for their removal.

The geometric or dimensional design of the flight strip itself is based largely on the operational needs of expected traffic and relates to vertical, horizontal, and side clearances, including the length and width of runways, shoulders, and end zones as well as approach zone areas.

The approach zone to a flight-strip runway is a trapezoidal area 500 ft wide at the end of the runway extended, and 4,000 ft wide at the zone limit 2 miles distant. Within this trapezoidal area no obstacles, either natural or man-made, may be permitted which are high enough to stand above a 30-to-1 glide angle projected from the end of the runway extension, and wherever feasible a 40-to-1 glide angle is adopted. In addition to the clearances provided at the approach zones, clearance is required along both sides of the flight strip and extending above a plane projected on a 7-to-1 slope from the edge of the runway and runway extensions for a zone width of at least 500 ft. There should be no obstructions on the shoulders.

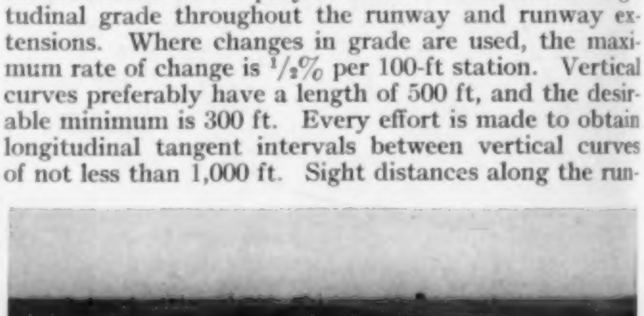
DIMENSIONS OF RUNWAYS AND EXTENSIONS

The over-all dimensions of the flight strips designed for military use include a normal length of 8,000 ft. However, there may be cases where a particularly good site will fall short of this. Such cases, of course, require special consideration. In general the total width of these strips is not less than 500 ft or more than 1,000 ft. Nearly all present designs call for a width of 500 ft. The paved runway has a width of 150 ft and a length of 4,000 ft at sea level. At higher altitudes this is increased, ranging up to a length of 8,000 ft at an altitude of 8,000 ft.

At each end of the paved runway there is a "runway extension" of the same width as the paved runway, usually prepared of some form of soil stabilization. The purpose of these extensions is to provide additional runway length, at low cost, for the planes that may require a runway longer than the paved length. The shoulders on each side of the paved runway have a width of 175 ft and extend for the entire length of the paved runway and runway extensions. On certain projects, portions of the shoulder areas for a length of 6,000 ft (at sea level) are stabilized, surface treated with bituminous material, or turfed.

Runway and shoulder grades are relatively flat. The maximum transverse runway grade is $1^1/_2\%$, with a minimum slope of 1%. The 1% transverse grade is considered the more desirable. Runways may have one-way or two-way transverse slopes. Where a two-way slope is used, the surface is made up of two intersecting planes. Parabolic or circular crowns are not used. This is to avoid the possibility of water standing in the central and most used portion of the runway. The maximum transverse slope of shoulders is 1.5%, with a minimum desirable slope of five-tenths of 1%.

In no case do shoulders slope toward the runway. The maximum longitudinal grade of runways is $1^1/_2\%$. However, if feasible, 1% should not be exceeded. A considerable number of projects have an unbroken longitudinal grade throughout the runway and runway extensions. Where changes in grade are used, the maximum rate of change is $^1/_2\%$ per 100-ft station. Vertical curves preferably have a length of 500 ft, and the desirable minimum is 300 ft. Every effort is made to obtain longitudinal tangent intervals between vertical curves of not less than 1,000 ft. Sight distances along the run-



FINISHED RUNWAY WITH STABILIZED GRAVEL RUNWAY EXTENSION IN FOREGROUND
Note Unimpeded Approach Possible from Every Angle

Power Graders Transforming Farm Land Into a Satisfactory Subgrade

ways are so designed as to permit an unobstructed view for their entire length as determined from a pilot's eye at an elevation approximately 10 ft above the runway surface.

RUNWAYS DESIGNED FOR HEAVIEST PLANES

Structural designs relate largely to the type of surfacing used on runways and shoulders to accommodate expected traffic. An important consideration is to design the subgrade with sufficient and uniform bearing power. At each location soil studies are conducted to determine the bearing values of the natural subgrades. Any deficiencies are corrected before pavement construction is undertaken. The thickness of the prepared subgrade will depend directly on the maximum loads it is to support and on the bearing value of the material used in its preparation, and indirectly on climatic conditions.

In no case are designs for runway pavements based on a wheel load of less than 12,500 lb. In all cases they are safe for much greater loads or easily may be strengthened to carry the heaviest planes.

For a number of years it was standard practice to add an impact factor to the static wheel load. Now it is believed that the critical load may be that imposed by the wheels of the standing plane rather than the sudden forces developed during operating maneuvers. The force exerted against a runway pavement by the wheels of an airplane when standing still can be determined without difficulty, but when a plane is in motion, either in preparing to take off or as the wheels make contact in landing, the forces are very difficult to determine. It has been observed that surfaces of the flexible type, including the various bituminous treatments which satisfactorily sustain the weight of standing airplanes, do not fail structually under the forces developed by the same airplanes in motion. Consequently at the present time there is a definite trend away from the use of any impact factor whatever.

The maximum wheel load of the airplanes of today is several times greater than the maximum permitted by law on the highways. Also, the size of the tire used on the landing wheels of airplanes is correspondingly greater than the sizes used on motor vehicles.

There are other important differences between the motor vehicle and the airplane with respect to their effects on pavements. For example, the time duration of stress from dynamic loading is probably appreciably less in a runway than it is in a highway; and finally, the frequency of load repetition at a given point in a highway pavement is much greater than that on a flight strip. Consequently, it seems unnecessary to consider fatigue of the concrete as a factor in the structural design of rigid pavements for flight strips.

HOW TO DETERMINE THICKNESS OF SURFACING

Structural strength of a given type of pavement is dependent on its thickness and support. For flexible-type surfaces, the thickness of the wearing surface, base course, and subbase considered as a unit, are predicated in part on the observed behavior of soils in highway and airport construction, and in part on such results of research as are available.

Quite recently the Public Roads Administration published an article entitled "Classification of Soils and Control Procedures Used in Construction of Embankments," which may be used as a guide in studying soil characteristics and their classification as related to the thickness of flexible-type pavements. For a number of years the State Highway Department of California has investigated the design and service of flexible-type pavements on highways in that state, and has developed a method of designing the bearing capacity of such pavements that has satisfactorily met their needs.

In June 1942, the War Department, Office of the Chief of Engineers, published Chapter XX of its engineering manual, entitled "Design of Runways, Aprons, and Taxiways at Army Air Force Stations." The brochure contains curves, illustrations, and data for designing flexible-type pavements based on the theory and practice developed in the State of California. It seems likely that this brochure and the methods that have been developed in California will go a long way toward clarifying design principles as applied to flexible-type pavements.

The thickness of such surfaces will, of course, depend largely on the character of the material used in their construction and the bearing power of the subgrade on which they rest. For heavier wheel loads and soils of low bearing value, a total thickness of as much as 24 or 30 in. may be required, whereas for the lighter loads, higher-type surfaces, and soils of high bearing value, as little as 6 to 10 in. may be adequate. Bituminous wearing courses on flexible bases are seldom less than 2 in. thick. Engineers are in agreement that during the emergency the use of steel in concrete pavements should be limited to the minimum compatible with sound engineer-

Loading Base Course Material at a Borrow Pit
Availability of Such Material Influences Choice of Site

PAVER PLACING SAND ASPHALT ON ROLLED SUBBASE

ing procedure. This policy is being adhered to in the flight-strip program.

SPECIAL ATTENTION GIVEN TO DRAINAGE

Drainage of flight strips is a major problem, but a relatively simple one when compared with the drainage of airports having a number of intersecting runways. On many airports subdrainage structures must be provided to intercept and remove storm water, to drain water from seepage planes in the soil, and to lower the water table. In such cases drainage becomes an important factor in the cost of airport construction. In the case of flight strips the problem is considerably simplified and drainage structures may be entirely eliminated or used only to a minor extent. Runoff resulting from rainfall or melting snow flows across the runway pavement and shoulders to shallow open ditches along the outer edges of the area.

Where storm drains or subdrains are needed along the edges of runways, open-joint or other equally suitable type of pipe is placed in a trench and backfilled with gravel or crushed stone to a point 12 in. below the top of the trench. The top 12 in. is composed of coarse stone pre-mixed with bituminous material firmly tamped or rolled into place. This prevents displacement by wheels and the blast of propellers and serves also as a transition strip for aircraft passing from the relatively rigid runway to the softer shoulders.

While the shoulder adjoining the paved runway of a flight strip in no case should be less than 150 ft wide, it is not always necessary that mechanical stabilization be carried the entire width. Ordinarily, stabilizing would be carried from about 75 to 100 ft from the edge of the runway. The shoulders of flight strips bear the same relation to the paved runway that the shoulders of a road bear to the paved roadway. Shoulders are primarily "run-over" areas, and the portions adjacent to the runway will have more traffic than distant portions. It is therefore apparent that the stabilization should be greatest adjacent to the paved runway and may decrease from that point to zero as the ditch line is approached. Generally, a uniform depth extending from the edge of the runway across the shoulder for a width of 50 to 75 ft, and then decreasing as it approaches the outer edge, will be found suitable.

Over stabilized and unstabilized areas, it is frequently desirable to either seed or sprig when the soil and general weather conditions are such that grass will grow. Where grass will not grow, a bituminous dust layer may be applied. Where shoulders, runway, and runway extensions are surfaced or treated with bituminous material, there should be a stripe painted around the runway to distinguish it from less substantial areas. Runway visibility may also be obtained by using a finish of light-color aggregate on the bituminous surface.

In some instances fencing is erected at boundaries of flight-strip areas to prevent hazards to aircraft from grazing animals and trespassers.

CONSTRUCTION METHODS

Clearing and grubbing, grading, drainage, and paving are the principal construction operations. Of these items, grading and paving are the most expensive, consume most of the time, and are most important to the successful operation of the flight strip.

A large portion of a flight strip area is composed of embankment. During the emergency, runway pavements are likely to be placed immediately, or shortly, after the embankment has been completed. Therefore every effort should be made to secure optimum compaction of fill material and thus avoid subsequent settlement and damage to pavement.

Methods used in the construction of flexible-type bases and surfaces follow those developed by the state highway departments in cooperation with the Public Roads Administration, and they represent best current practice. A number of types of bituminous surfaces can be satisfactorily constructed with local aggregates. Examples are sand asphalt pavement and several types of open-graded and dense-graded bituminous mixtures. One type commonly used on flight strips is the plant-mixed bituminous surface laid to a minimum compacted thickness of 2 in. For relatively light traffic, other acceptable types are surface treatments not less than $1^1/_2$ in. thick, of penetration macadam, road mix, or mixed-in-place treatments.

For many years articles have been written and discussions held on the subject of flight strips. However, other than preliminary legislation, no action was taken to provide for their construction until the present war emergency. During this emergency they have developed into a reality because they answer the need for landing fields that can be built quickly and with a minimum of critical materials, man power, and money. It is particularly gratifying that all the participants in the program—Congress, the War Department, the Government agencies, the state highway departments, and the contractors—are pulling together, toward the end of building the projects in the shortest possible time.

ROLLING SAND ASPHALT

Gaging and Sampling Louisville's Sewage

Flumes Constructed in Sewers and Coordinated Sampling Program Give Valuable Data

By C. Frank Johnson, Assoc. M. Am. Soc. C.E.

Chief Engineer, Commissioners of Sewerage of Louisville, Louisville, Ky.

From 22 outlets along the Ohio River, Louisville's sewage was being discharged untreated. Recognizing the health menace of such a procedure, the Commissioners of Sewerage of Louisville in 1939 authorized a thorough investigation of existing conditions so that appropriate steps might be taken to provide adequate disposal facilities. A part of this investigation was the gaging and sampling of the city's sewage, here described by Mr. Johnson. This work was unique in several respects, particularly in the manner of keeping a continuous record of discharge by means of flumes constructed directly in the sewers.

An investigation of the needs for intercepting sewers and sewage treatment for Louisville, Ky., was made in 1939–1940. As part of the work, a study—Louisville's first—was made of the quantity and characteristics of the city's sewage, all of which was being discharged, untreated, into the Ohio River. The gaging and sampling work done as a part of the investigation is here described.

The trunk and main sewers of Louisville have 22 outlets, all located along the left bank of the Ohio River. For 11 of the outlets, studies indicated that the sewage flow could be gaged at suitable points near enough to the outlets so that substantially the total discharge could be measured. For 5 of the outlets, however, it was found that the sewer was submerged to such a distance from the outlet, by the backwater of the river, that one or more important branches entered the main sewer below the point where gaging could be done. Therefore, it was necessary to gage the flow in these 5 main sewers and their branches separately, utilizing 19 gaging points for the 5 outlets. At the remaining 6 outlets the discharge was very small, so was not gaged.

In order to estimate the maximum and minimum capacities needed for the gaging devices, depth-of-flow measurements were made at random times in each sewer, and the corresponding discharges were computed. Based on these computations, anticipated maximum and minimum dry-weather flows were estimated for each sewer. It was desired to gage primarily the dry-weather flow, and secondarily the first runoff of storm water, up to a total flow (sewage plus storm water) of about three times the maximum dry-weather discharge. With this in view, a study was made of the various practicable methods of gaging the discharges anticipated, keeping in mind also the desirability of using automatic water-level recorders to obtain continuous measurements over a considerable period. As a result of this study, the Parshall measuring flume was selected for use.

There were several reasons for selecting the Parshall flume: it is practically free from clogging, which is of major importance in a sewer; it operates with small loss of head; its accuracy is unaffected until the degree of submerged flow reaches 70%; the velocity of approach of the water to the entrance of the flume has little or no effect on the rate of discharge of the flume; it is particularly adapted to the use of an automatic recorder; its accuracy is sufficient for sewage flows, as the measurement is correct within 3% in about 90% of the tests reported upon by Mr. Parshall; and finally, it is simple and easy to construct of metal, lumber, or masonry, as it has plane surfaces. In all respects except accuracy, the Parshall flume was considered to be more suitable than the weir for the work planned. A typical installation of the flume and recording device is shown in Fig. 1.

Flumes were utilized at 22 of the gaging points. The recorders were placed in shelters above the street or ground surface where possible; elsewhere they were placed on shelves in the manholes.

In three of the sewers it was found impracticable or undesirable to install flumes, partly on account of the cost of the reconstruction work necessary to obtain sufficient room, and in the case of two of the sewers, partly on account of the large flow. Therefore, in these three cases the discharge was measured by utilizing the depths of flow and the slopes of the sewers, using the Kutter and Chezy formulas. The value of n in the Kutter formula was determined for each sewer by salt-velocity measurements made in the field for this purpose. In each of these three

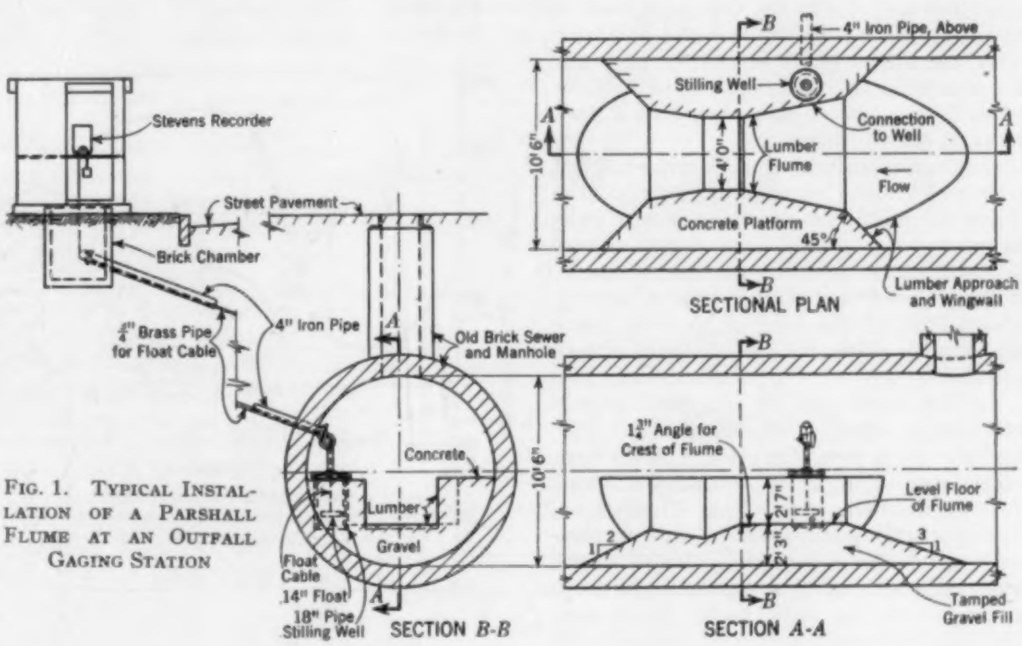


Fig. 1. Typical Installation of a Parshall Flume at an Outfall Gaging Station

METAL FLUMES IN ASSORTED SIZES PRIOR TO INSTALLATION IN OUTFALL SEWERS

sewers the recorder float was installed so as to indicate the depth of flow in the sewer.

At four of the five remaining gaging stations, located on small sewers having low flows, Cipoletti weirs were used. These were formed of galvanized metal plates, bolted to wooden bulkheads cut to conform to the shape of the sewer. Heads on the weirs were measured by an observer at hourly intervals during one or more 24-hour periods, no automatic recorder being installed. At the one remaining gaging station, no gaging device was needed, since chart records of a sewage-pumping station were available for computing the flow.

SPECIAL GAGINGS MADE

Measurements made at the 30 gaging stations described were known as "regular" gagings. In addition to these, "special" gagings were made at 6 selected points in certain sewers for the purpose of ascertaining typical unit rates of sewage flow from residential and from industrial areas. Also, "industrial waste" gagings were made at 11 typical and varied industrial plants for the purpose of ascertaining flow rates and characteristics (by sampling) of industrial wastes being discharged into the sewers. At all these additional gaging points, right-angle V-notch weirs and rectangular weirs, similar in construction and use to the Cipoletti weirs mentioned, were utilized. No automatic recorder was used, but the heads were measured by an observer at regular intervals, in most cases 10 or 15 minutes, during the gaging period of 1 to 7 days at each location.

Gagings were carried on continuously at only 8 of the 30 "regular" gaging stations. That this would be satisfactory was indicated by the preliminary depth-of-flow measurements and computations made, which showed that these 8 sewers, serving about 92% of the area of the city, were discharging about 90% of the total sewage of the city.

At the remaining 22 "regular" gaging stations, a schedule of intermittent gaging was used, since the sewage flows were considerably less than at the 8 stations just mentioned. For these 22 stations, four portable water-level recorders were utilized. These recorders, being small, were especially suitable for use in the small manholes on the old sewers. Each portable recorder was installed at a gaging station, left in place for at least 7 full calendar days, then moved to another location, where a similar gaging was made. (The flumes were not moved.) In the most important of these sewers, the 7-day gagings were repeated at 6 to 12-week intervals.

The sewage discharges gaged checked well with the city's water consumption for the same period, the ratio of the average dry-weather sewage flow to the amount of the water supply being about 91%. This is not an abnormal proportion. Furthermore, an analysis of the city's daily water-consumption figures for the entire year, compared with those for the gaging period (about 6 months), indicated that the sewage discharge gaged could safely be taken to represent the yearly average.

In Fig. 2 is shown the total sewage discharge of the entire city, as gaged on certain days of extreme flows. For sewers that were not gaged on the dates shown, discharges were taken from the nearest comparable day when gaging was done, using the same day of the week.

DISCHARGE OF AIR-CONDITIONING WATER

Among the most interesting gagings are those of the discharge from the principal downtown commercial area, showing the effect of air-conditioning water on sewage flows. It is shown that during the warmer months the daily discharges from the sewers in the downtown area increased or decreased as a function of the outside air temperatures except on days when commercial establishments were closed. The effect on the hourly discharges of one sewer is illustrated in Fig. 3.

Three of the "special" gagings were made in districts predominantly residential, for determining typical rates of domestic sewage flow. The results of the gagings in these districts are of interest, particularly in that the 4 to 5 p.m. low point (88% of the daily average) was followed by a pronounced 7 to 8 p.m. peak (141% of the average). Discharges of all the sewers in this group were similar. In the three districts the average flow of domestic sewage for a 2-day period, after allowing for the sewage from small commercial and industrial areas, was 52 gal per capita per day (the estimated population of these districts was 9,390). Substantiating this value to some extent, the yearly average amount of water used by domestic consumers over the entire city was computed to be from 50 to 55 gal per capita per day. Trial computations of the sewage discharge of the entire city, based on various tentative rates of domestic flow and of

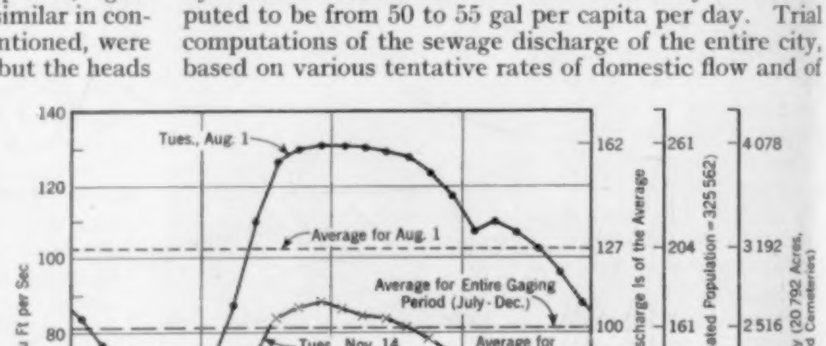


FIG. 2. DRY-WEATHER DISCHARGE FROM ALL CITY SEWERS

flows from commercial and industrial areas, resulted in the acceptance of a rate of 55 gal per capita per day for the domestic sewage flow.

To aid in determining rates of flow from commercial areas, a survey was made of the water consumption of 30 typical small commercial establishments of the "neighborhood" type. This rate was found to average from 3,500 to 4,000 gal per acre per day (including in the area any vacant portion of the lot in the rear, and taking the area to the center-line of the abutting streets). Based

WOODEN MEASURING FLUME INSTALLED IN A 10-FT 6-IN. CIRCULAR SEWER, WITH STILLING WELL AT RIGHT

on this quantity, and on a study of the sewage gagings made, the following values for sewage flows from commercial areas were determined:

TYPE OF COMMERCIAL AREA	GAL PER ACRE PER DAY
"Neighborhood"	4,000
Downtown	35,000
Intermediate	10,000

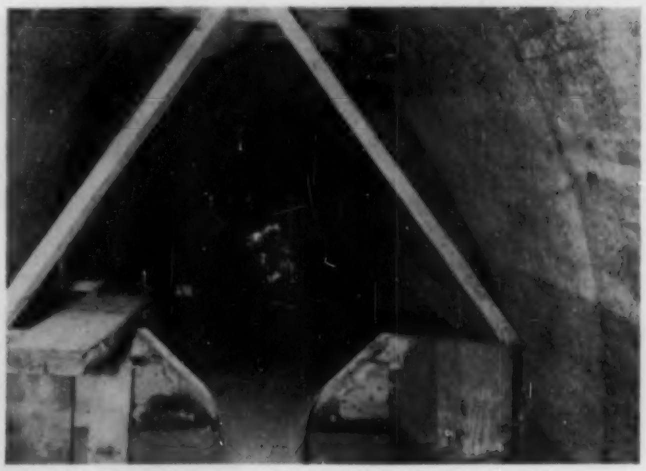
The weighted average of these rates, for all the commercial area of Louisville, is 7,500 gal per acre per day. These rates are in addition to the domestic flows from the same areas.

The average rate of sewage and waste flow from industrial areas was determined by subtracting the sum of the flows from the residential and the commercial areas from the total city flow measured by the gagings, and dividing the remainder by the area of the tributary industrial districts. This gave approximately 14,000 gal per acre per day, which was accepted as the average rate of waste discharge from the industrial areas.

INDUSTRIAL WASTE FLOW VARIES WIDELY

However, it was apparent from the gagings that the rate of waste discharge from industrial districts actually varies between wide limits for different industries and even for different plants of the same industry. Gagings made in sewers serving small industrial areas showed average flows varying from 1,200 to 17,000 gal per acre per day. On the other hand, gagings of the sewage and waste discharge from 11 industrial plants which were users of large amounts of water showed an average flow from all the plants of 36,900 gal per acre per day on the days when the gagings were made. The average values at individual plants ranged from 5,770 to 364,000 gal per acre per day. It should be remembered, however, that most of these plants do not operate at full or even near-full capacity throughout the year, so the yearly average discharges are probably less than those determined during the 2-day and 7-day gagings.

It was apparent that the application of average unit rates of flow to the areas of individual commercial and



RIGHT-ANGLE V-NOTCH WEIR USED FOR GAGING INDUSTRIAL WASTE FLOW

industrial districts was not the ideal method of determining total discharges from these districts. However, for the purposes for which they were desired—that is, the design of intercepting sewers and a sewage-treatment plant—these average rates appeared to be satisfactory.

In determining the unit rates of sewage discharge, just described, the ground-water flow was given no value. Therefore, the rates determined for domestic, commercial, and industrial flows include the amount of ground water that was actually flowing in the sewers during the gaging period. However, it was indicated by various data available, in addition to the gaging data, that the ground-water flow was probably very low during this period. (An average value of 500 gal per acre per day was determined to be the proper allowance for the design of intercepting sewers.)

SAMPLING THE SEWAGE

Composite (24-hour) samples were collected periodically in the 30 sewers in which the "regular" gagings were made, the samples being taken at or near the gaging devices so that the individual portions, taken at hourly

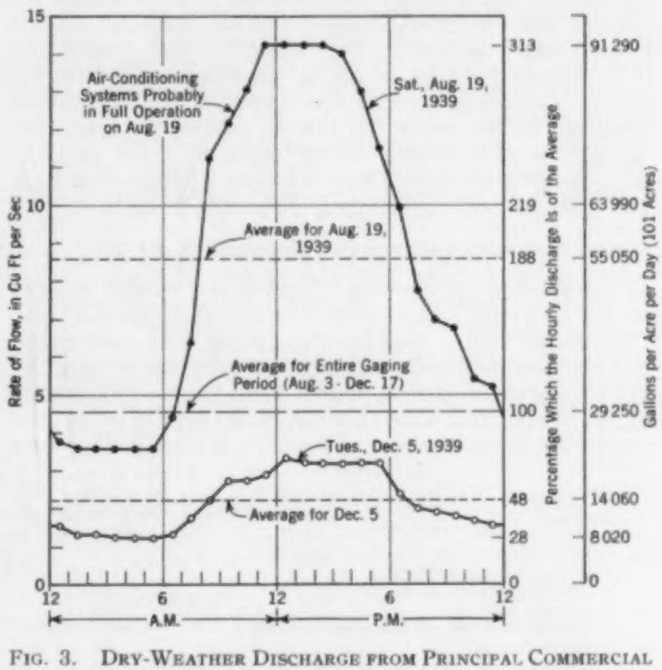


FIG. 3. DRY-WEATHER DISCHARGE FROM PRINCIPAL COMMERCIAL DISTRICT ON DAYS OF MAXIMUM AND MINIMUM DAILY FLOWS

intervals, could be proportioned according to the sewage flow. A composite sample was secured in each sewer at 3 to 12-week intervals, depending on the importance of the sewer. The total number of composite samples collected in these sewers was 119.

Samples were collected from two, three, or four different sewers on the same date, depending on the distance between sampling points. A two-man sampling crew, traveling in a one-ton truck, maintained a regular schedule each hour. Three 8 to 9-hour shifts were used.

The sampling crew was provided with data sheets showing the sizes of the individual portions, in fractional ($^1/_8$) cups, to be taken for various ranges of heads shown by the recorder in place at each sampling point. The sizes of the individual portions were computed in advance on the basis of previously measured average flows, so as to result in a 24-hour composite sample of about 2 quarts in dry weather. The largest individual portion taken was $1^1/_2$ cups, intended to represent a flow of about three times the computed average dry-weather flow. During rainstorms the size of the portion was not increased over $1^1/_2$ cups when the flow exceeded three times the average.

STEVENS WATER-LEVEL RECORDER LOCATED IN SHELTER ABOVE MANHOLE

When taking the individual sample, the sampler took, by means of an aluminum dipper, a total of about two-thirds of a quart, which he collected in an aluminum pail. The dipper was inserted deep into the flowing sewage, and large floating solids were avoided. After the temperature of the sewage was taken, the pail containing the sewage was vigorously shaken and the required portion poured into a measuring cup, whence it was poured into a 2-qt glass jar kept in an ice chamber carried on the truck. Complete records were kept for each individual portion. At the end of the 24-hour period, the composite samples were delivered to the laboratory for analysis. An average analysis of Louisville sewage, computed from the analyses of these samples, is given in Table I.

SAMPLES TAKEN AT FREQUENT INTERVALS

Composite samples were collected in a similar manner at the 6 sewers and 11 plants where the "special" and "industrial waste" gagings were made. At each point, the samples were collected during the period covered by the gaging made at that point. Individual portions were taken at the same time that the heads on the weirs were measured, in most cases, at 10 or 15-min intervals. As a rule, sampling could be carried on at only one point at a time, on account of the short interval between the taking of the individual portions. As these short intervals resulted in larger composite samples, a 5-gal carboy was carried on the truck for making composites of the samples. No ice was used for these samples, as they were collected during winter months. The total number of composite samples collected at these points was 67, and in addition many "catch" samples were taken for special analyses.

During the gaging periods, data were obtained regarding the amounts of raw materials used and finished goods produced in the plants, in order to correlate the flows and analyses with plant activity. Also, like data were obtained from all major industries of the city.

The gaging and sampling work was done by engineers of the Commissioners of Sewerage of Louisville, under the general direction of the late Woolsey M. Caye, M. Am. Soc. C.E., then technical engineer for the Commission, with the aid and advice of Metcalf and Eddy, Boston, Mass., consulting engineers. The U.S. Public Health Service and the Kentucky State Board of Health cooperated in certain parts of the work. Installation of flumes and weirs, and other construction work, was done by day-labor forces of the Commissioners of Sewerage, under the direction of John J. Loehr, M. Am. Soc. C.E., then designing engineer, and A. H. Boerner, then construction engineer for the Commission. J. F. Kuchar was chemist in charge of the laboratory work. The writer, then senior engineer for the Commission, assisted on the construction part of the work and was in immediate charge of the gaging and sampling. The data secured by the gaging and sampling work proved to be invaluable in studying the needs for intercepting sewers and sewage treatment for Louisville.

TABLE I. AVERAGE ANALYSIS OF LOUISVILLE SEWAGE

CHARACTERISTICS	PPM, EXCEPT AS NOTED
Hydrogen-ion concentration (pH index)	7.5
Settling solids (cc per liter)	1.6
Turbidity (silica standard)	233
Alkalinity as $CaCO_3$	246
Biochemical oxygen demand—5 days at 20 C	19.8
Suspended solids	161
Chlorides	83
Chlorine demand	7.4

SAMPLING INDUSTRIAL WASTE ABOVE V-NOTCH MEASURING WEIR

Road Construction on Western Cantonments

Local Materials Determine Design of Camp Streets and Access Routes

By Don Hull McCreery, Assoc. M. Am. Soc. C.E.
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The toughest service a road gets is from the heavy track-laying vehicles so widely used by the Army. Camp service and access roadways must withstand this continuous abuse with the minimum of maintenance. In his description of this construction on a large number of cantonments, Mr. McCreery stresses the successful use of materials found near the camp sites—materials which had to be utilized because of the impossibility of providing for the transportation of outside aggregate.

Engineers and contractors alike were faced with a tremendous road job when the program of cantonment projects started in 1940. The road, street, and highway construction in connection with these projects in the western states was of such scope and magnitude as to constitute a major part of the defense work in this area. As each cantonment needed not only interior streets and highways, but also access roads and extensions to existing county and state routes, all types of road building were encountered. Indeed, at one time or another, almost all the problems encountered by state highway designers were met by engineers on cantonment work.

Because of the nature of the projects and the times, solution of these problems depended largely on local conditions and the military requirements for the particular project. Locally available materials, soil conditions, and topography were the governing factors in design, with the Army setting the limits as to road types and widths. Highway standards of the states in which the camps were located were used to as large an extent as possible as a basis of design, and standard practices for particular localities were adhered to.

Since facilities for transporting material any distance were not available, the nature of the local material was the factor that practically dictated the detailed design. At one camp a fairly soft red shale furnished satisfactory material for a subbase, while at another site, not far distant, deposits of white lime shale, quite different from the red shale, were used for the same purpose. The designs of the roads in the two camps were varied to fit the materials used and both road systems have given satisfactory service.

In general, the cantonment roads and streets were of three classes, the classification depending on the use and importance of the particular road. The first-class, or primary roads, were those subject to continuous heavy traffic and were principally the main entrance roads, the main arteries to and from warehouse areas, and the main arteries serving motor parks. For the more permanent types of camp, such as mobilization cantonments, the primary roads were generally portland-cement concrete, while for theater-of-operations camps these roads were limited to an asphaltic concrete pavement on an aggregate base course. The type of troops for which the camp was intended determined the cross-sectional dimensions of the primary roads. For instance, a camp to be used only by an infantry division obviously required a lighter road section than a camp to be occupied by artillery troops or an armored division. A typical cross section of a primary road in a camp for an armored division is shown in Fig. 1.

Asphaltic Concrete Surfaces

The second-class roads generally run longitudinally through the camp and serve as the main distributing thoroughfares. They are subject to continuous but not necessarily heavy traffic. Barring special conditions, they are of asphaltic concrete pavement—usually "plant mix"—on a fairly heavy base of the best local material obtainable. The pavement thickness of secondary roads varied according to the importance of the road—2 in. being the minimum and 4 in. the maximum. The type and thickness of the base course is constant for all secondary roads. Also shown in Fig. 1 is a typical cross section of a secondary road as constructed in both an armored division cantonment and in a square division (infantry) cantonment. Primary roads in theater-of-operations camps were similar to this type.

All secondary roads were given a seal coat of penetration-type asphaltic emulsion or an SC-4 liquid asphalt applied at the rate of 0.15 to 0.25 gal per sq yd of surface and a covering of medium screenings (passing a $^3/_8$-in. and retained on a No. 6 screen) spread at the rate of 20 to 25 lb per sq yd. The emulsion gave the best results, but could be used only in favorable weather. Shoulders on both primary and secondary roads were treated to the design width with 0.25 gal per sq yd of SC-2 or SC-3 liquid asphalt and covered with 16 to 20 lb per sq yd of sand or fine screenings (passing the $^1/_4$-in. and retained on the No. 10 screen). There was one exception to this, however. It was found that when the lime shale was used for subbase and shoulders on the roads for armored divisions there was no need for further treatment, as the shale when wetted and rolled gave an entirely satisfactory shoulder surface, even in wet weather.

In the third class are the camp streets intersecting the secondary roads and serving the troop housing areas.

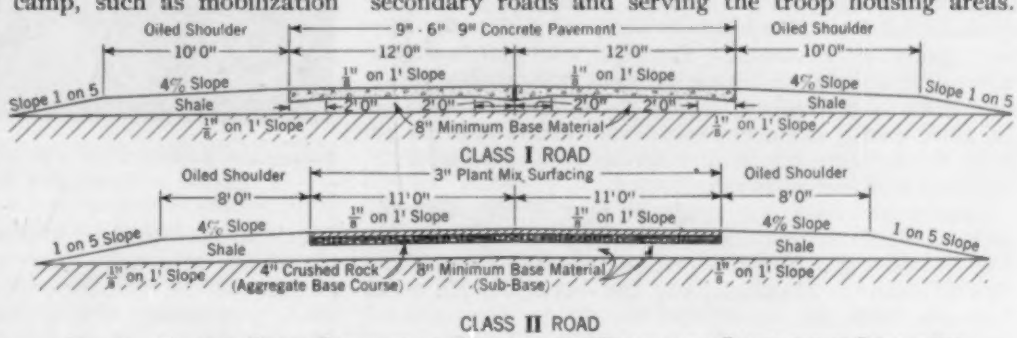

Fig. 1. Typical Cross Sections of Primary and Secondary Cantonment Roadways

PLACING TRANSIT-MIXED CONCRETE ON A PRIMARY ROAD IN A CANTONMENT

They are not intended to carry heavy loads or continuous or fast traffic, and their design is therefore relatively light and inexpensive. Experience has shown that while these roads are entirely serviceable for the traffic intended, they will not stand up under heavy or fast military traffic such as tanks, track-laying vehicles, or trucks moving at high speed.

LIGHT GRADING BY POWER GRADERS

Third-class roads were usually built to conform closely to the natural ground or area grading, and plan and profile sheets were not furnished for construction. The grading was very light and was to a large extent completed by power graders. The roads generally consist only of a base course 12 in. thick under an armor coat of SC-6 liquid asphalt and screenings. The base-course material was the same as that used for the subbase on secondary-type roads and varied according to the site—lime shale, "red-rock" shale, and decomposed granite were some of the materials used. The armor coat was placed in three applications, with an ultimate thickness of approximately 1 in.

Access roads, that is, roads outside the camp area proper, connecting to state highways or county roads, were similar to the secondary roads in design, although generally lighter. These roads, too, varied in section and width according to their importance in the camp system and the probable traffic load. The principal access roads from important state highways to the main camp entrance were built with a fairly heavy base and a 3-in. plant-mix surface 24 ft wide. Less important connections had a lighter base and a 2-in. plant-mix surface 22 or 24 ft wide. The least important links were graded and drained and given only the minimum surface treatment necessary. No plan and profile sheets were provided for this type of road, the grades being staked so as to conform closely to the natural surface. In some special cases, however, main access roads were built to the same design and specifications as the state highway with which they connected.

Special provision was made at road or street intersections used by vehicles with caterpillar-type treads. The toughest service a road gets is from the turning action of this type of vehicle, and the damage to the road increases with the speed and weight of the vehicle. Therefore, in the camps for armored divisions particularly, primary and secondary road intersections to be used by tanks and other track-laying vehicles were made of portland-cement concrete in the T-shaped area subject to the turning action.

Motor parks presented a problem in design that differed in several respects from the road problems. Whereas the traffic on roads and streets is assumed to move smoothly in straight lines generally parallel to the axis of the road, the traffic in motor parks moves in all directions, and is subject to sudden starts and stops and frequent sharp turns of all types of vehicles. In addition, there are concentrations of heavy stationary loads to be taken care of.

Motor parks, therefore, required a heavy base course of the same materials used for the subbase course on the roads. Surfacing varied with the nature of the base material. It was found with the lime shale that nothing more was needed for a surface, because this material when wetted and rolled made an entirely satisfactory motor park under all conditions, whereas the "red-rock" shale used in a neighboring camp went to pieces under traffic when wet, and it was there necessary to provide an asphalt pavement.

DRAINAGE REQUIRED SPECIAL TREATMENT

Because motor parks occupy large unbroken areas, their drainage required special treatment in many cases. If, as occasionally happened, a park was on a general slope, the drainage was simple. However, most of the motor parks were so flat or so sloped that special provisions had to be made to give satisfactory drainage. Usually this was done by open-tile waste-water lines in rock-filled trenches, but in some cases catch basins and waste-water sewers were required.

Thorough study was given to the drainage problems on each project, and ample provision made in the road designs for side ditches, culverts, bridges, or other structures needed. The Talbot and Berkli-Ziegler formulas were used to determine runoff. However, in view of the expected limited life of the camps, the maximum intensity was set at 1 in. per hour. It was considered advisable to over-design culverts because experience had shown that soldiers' minds were occupied with affairs other than the keeping clear of culverts and ditches.

AGGREGATE BASE COURSE FOR A SECONDARY ROAD RECEIVING PAVING OF PLANT-MIX BITUMINOUS CONCRETE

In the mobilization cantonments, more permanent structures were used than in the theater-of-operations camps. In the latter, culverts were used only where absolutely necessary, dips and fords taking their places at all other crossings. In areas subject to thunderstorms, special allowances had to be made on the larger drainage channels for flash floods of relatively large volume and

short duration. This was usually accomplished by providing cheap drainage structures that could handle ordinary flows. Although they would go out with the occasional peak flood, they could be quickly and easily replaced.

As the Engineering Manual issued by the War Department through the Office of the Chief of Engineers was not available until early in 1942, the road systems in the earlier cantonments were designed without the benefit of its guidance. It is gratifying to note that the roads as designed and built comply in practically all respects with the standards of design set up in the manual.

Equipment Difficult to Obtain

It has been the practice to award all the roadwork in one cantonment to one contracting organization. In some cases this was a subcontractor to the general contractor on the project, but more recently the roadwork has been done as a prime contract with the Government. In either case, this concentration of all the roadwork in a cantonment with one organization has introduced several construction problems not ordinarily met with in this type of work elsewhere. Probably the knottiest of these problems—and certainly the one with the most headaches—was the procurement and maintenance of equipment. Under war conditions it was extremely difficult for a contractor to buy new equipment and no easy matter to obtain used equipment. It was therefore a job of some magnitude to adequately equip a project of the size of a road contract on a cantonment.

Likewise, the maintenance of the contractor's equipment was a big job. On cantonment work, because of the necessity for speed, it was imperative that the work be carried on 24 hours a day, and commonly under conditions far from ideal. For instance, at one camp constructed during the summer and fall months the ground was so dry and powdery that each piece of equipment traveled in its own thick cloud of dust, while at other camps, constructed during the winter of 1940-1941 the equipment was continually fighting mud—mud that was deep and heavy. All these conditions aggravated the

Spreading Shale on Completed Subgrade of an Access Road

problem faced by the contractor in maintaining his equipment.

Another feature of cantonment road construction that added to the contractor's problems was the spread of the work. In order to secure completion within the scheduled time it was necessary that construction be carried on simultaneously at as many points as possible. This meant that the contractor had to have plants and crews for all the types of roads required on the project. The spread of the work over large areas also increased the

Dust Was a Great Construction Handicap at One Camp

contractor's transportation worries. Serving all operations at all points of construction on a cantonment at one time calls for many more trucks and other transportation items than serving one type of operation along a single roadway project.

All Operations on a Twenty-Four Hour Basis

The same features that affected the road contractor increased the engineers' problems. Just as it was necessary for the contractor's forces to work at scattered points simultaneously, so was it necessary for the engineers to spread their survey and inspection forces over a wide area. And, like the contractor, the engineers had to have sufficient inspection personnel familiar with the different types of pavements to keep up with all operations on a 24-hour basis.

On these cantonment jobs it was essential to efficient conduct of the work that there be close cooperation between the contractor's organization and the engineer's field forces. Unless the engineers furnished the location surveys and slope stakes well in advance of the road work, the contractor could not make the required progress. On one project in a mountainous and somewhat remote section of the country, surveyors were so scarce that location surveys on the roads were only a quarter of a mile ahead of the construction. This made it impossible for the contractor to work his crews at their best efficiency.

Likewise, it was incumbent upon the contractor to contribute his full measure of cooperation lest there be loss of time and efficiency. If the engineers' field forces were called upon to find out for themselves where the contractor was working and what his next move was, frequent tie-ups or delays usually resulted, whereas when the contractor "played ball" with the engineers' field forces and kept them advised of his program, the engineers were able to do a better job with fewer men, and the production schedules were more often met.

A word of commendation should be said for the highway departments of the various states in which the cantonments were built. Their load was increased considerably thereby, but through it all they gave valuable help and cooperation to those engaged in the military construction program.

Engineers and contractors working together have now about completed, in the western states, the job that was set before them at the start of the defense program. Looking back, it can be said that there was, by and large, excellent cooperation shown by both engineers and contractors. The record they have made is one of which they may be justly proud.

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Economy Method of Computing Steel for Reinforced Concrete Columns

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FOR a reinforced concrete column subjected to compression and bending, with tension over part of the section, the most economical design will seldom be obtained when the full strength of the steel in tension is utilized. A method which might be called the economy method, for determining the steel tension stress that will give a minimum of steel in a column, is given here.

It is seldom that the areas of the compression and tension steel are alike. A general case, shown in Fig. 1, will

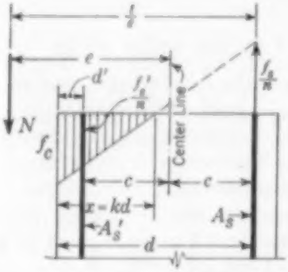


FIG. 1. SECTION OF COLUMN

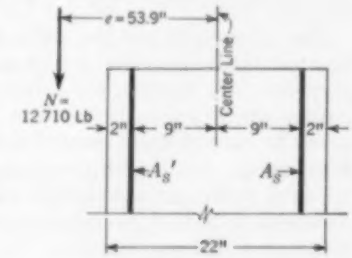


FIG. 2. EXAMPLE 1

therefore be used for the analysis. The nomenclature is as follows:

- f_s = tensile unit stress for steel
- f_c = compressive unit stress for concrete extreme fiber
- n = ratio of modulus of elasticity of steel to that of concrete
- A_s = cross-sectional area of the steel in tension
- A_s' = cross-sectional area of the steel in compression

For known values of n, f_c, and f_s,

$$k = \frac{nf_c}{nf_c + f_s} \text{ and } x = kd \quad \ldots \quad (1), (2)$$

$$f_s' = nf_c \frac{x - d'}{x} = nf_c \frac{k - d'/d}{k}, f_s = \frac{nf_c(1-k)}{k} \quad \ldots \quad (3a), (3b)$$

If moments are taken with reference to the steel areas, we get

$$N(e + c) = M_s = A_s' f_s' (d - d') + \frac{bxf_c}{2}\left(d - \frac{x}{3}\right) \quad \ldots \quad (4)$$

$$\text{and } N(e - c) = M_s' = A_s f_s (d - d') - \frac{bxf_c}{2}\left(\frac{x}{3} - d'\right) \quad (5)$$

Therefore the required steel areas will be

$$A_s = \frac{M_s' + {}^1/_2 \times f_c bx (x/3 - d')}{f_s (d - d')} \quad \ldots \quad (6)$$

$$\text{and } A_s' = \frac{M_s - {}^1/_2 \times f_c bx (d - x/3)}{f_s' (d - d')} \quad \ldots \quad (7)$$

Example 1. A column 12 by 22 in. (Fig. 2) takes an eccentric load. If the stresses are fixed as f_s = 20,000 lb per sq in., and f_c = 650 lb per sq in., find the reinforcement if it is assumed that n = 15 and d' = 2 in.

Using Eq. 1, we find that k = 0.328, so x = 0.328 × 20 = 6.55 in.

Now using Eq. 3, we get the steel stress in compression,

$$f_s' = 15 \times 650 \times \frac{6.55 - 2}{6.55} = 6{,}772 \text{ lb per sq in.}$$

and the moments with reference to A_s' and A_s will be

$$M_s' = 12{,}710\ (53.9 - 9.0) = 571{,}000 \text{ in.-lb}$$
$$M_s = 12{,}710\ (53.9 + 9.0) = 800{,}000 \text{ in.-lb}$$

Hence the steel areas become, by the use of Eqs. 6 and 7:

$$A_s = \frac{571{,}000 + {}^1/_2 \times 650 \times 12 \times 6.55 \times (6.55/3 - 2)}{20{,}000\ (20 - 2)} = 1.599 \text{ sq in.}$$

$$A_s' = \frac{800{,}000 - {}^1/_2 \times 650 \times 12 \times 6.55 \times (20 - 6.55/3)}{6{,}772\ (20 - 2)} = 2.830 \text{ sq in.}$$

Example 2. This is the same problem as Example 1, with the only change that the steel stress, f_s, is 18,000 instead of 20,000 lb per sq in. For this new value, A_s = 1.603 sq in. and A_s' = 2.675 sq in.

EFFECTS OF CHANGES IN STEEL TENSION STRESS

It will be found that when the steel stress was 20,000 lb per sq in., the total amount of reinforcement is 4.429 sq in. It will be found from Example 2 that when the steel stress was lowered to 18,000 lb per sq in., the total amount of reinforcement is 4.278 sq in. Therefore, by lowering the allowable steel tension stress from 20,000 to 18,000 lb per sq in., the total amount of reinforcement required was decreased.

The following derivation will show how the proper usable unit stress in tension can be obtained in order to get the most economical design:

By substituting in Eqs. 6 and 7, we get

$$f_s' = \frac{nf_c (k - d'/d)}{k}, f_s = \frac{nf_c (1 - k)}{k}, t = e + c, \text{ and}$$

$$A_s = \frac{Ntk\ [1 - d/t\ (1 - d'/d)] + {}^1/_6 \times f_c bd^2k^2\ (k - 3d'/d)}{nf_c d\ (1 - k)\ (1 - d'/d)} \quad \ldots \quad (8)$$

$$A_s' = \frac{Ntk - {}^1/_6 \times f_c bd^2k^2\ (3 - k)}{nf_c\ (k - d'/d)\ (1 - d'/d)} \quad \ldots \quad (9)$$

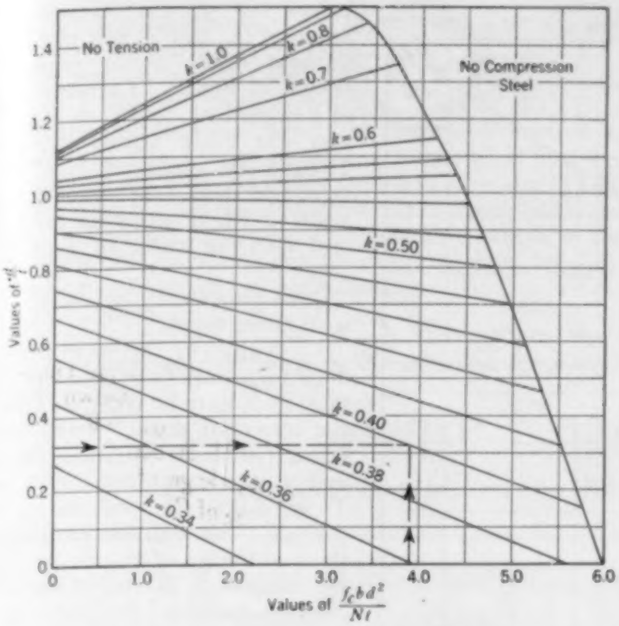


FIG. 3. ECONOMY CHART FOR VALUES OF k WHEN $d'/d = 0.10$
Similar Charts May be Plotted for Other Values of d'/d

Instead of having f_s as a variable, we have k as a variable. The problem is to find such a value of k as will make the sum, $A_s + A_s'$, a minimum. In order to do this, we add the right-hand terms of Eqs. 8 and 9, then take the first derivative of this expression. Taking this derivative as equal to zero,

$$\frac{1}{(1-k)^2} - \frac{d}{t} \times \frac{1-d'/d}{(1-k)^2} - \frac{d'/d}{(k-d'/d)^2} + \left[\frac{1-3d'/d}{(1-k)^2} - 4\left(1-\frac{d'}{d}\right) + \frac{3\frac{(d')^2}{d} - \frac{(d')^3}{d}}{(k-d'/d)^2}\right]\frac{f_c bd^2}{6Nt} = 0 \quad \ldots\ (10)$$

This is the general formula to determine the value of k in order to obtain a minimum of steel reinforcement in the section. However, it is an equation of the fourth power, and is very difficult to solve.

To simplify the method of finding k, the chart in Fig. 3 has been plotted. This chart gives the value of k for least amount of total steel area when $d'/d = 0.10$. A fixed value of d'/d is used to simplify Eq. 10, as follows:

$$\frac{1}{(1-k)^2} - \frac{0.1}{(k-0.1)^2} - \frac{d}{t} \times \frac{0.9}{(1-k)^2} + \left[\frac{0.7}{(1-k)^2} - 3.6 + \frac{0.029}{(k-0.1)^2}\right]\frac{f_c bd^2}{6Nt} = 0 \quad \ldots (11)$$

Originally there were three variables, d/t, $f_c bd^2/Nt$, and k. The first two having been used as coordinates in Fig. 3, k only remains.

If a fixed value of k is used, for instance, 0.4, then

$$1.667 - 2.5\, d/t = 0.222 \frac{f_c bd^2}{Nt} \quad \ldots\ (12)$$

As this is a straight line, only two points are required to locate it. Therefore, substituting zero for d/t in Eq. 12, it is found that $\frac{f_c bd^2}{Nt} = 7.51$, and when $\frac{f_c bd^2}{Nt} = 0$, $d/t = 0.667$.

The line connecting these two points represents a value of $k = 0.040$. Similarly, lines representing other values of k can be plotted.

In case no compression steel is required, the numerator in Eq. 9 must equal zero. Then

$$ntk - k^2(3-k)\frac{f_c bd^2}{6} = 0 \quad \ldots\ (13)$$

or

$$\frac{f_c bd^2}{Nt} = \frac{6}{k(3-k)} \quad \ldots\ (14)$$

This value may be called the outer limit for the chart. Thus for $k = 0.40$, the outer limit is

$$\frac{6}{0.4 \times 2.6} = 5.57 = \frac{f_c bd^2}{Nt} \quad \ldots\ (15)$$

This means that for $k = 0.4$, when the value $f_c\, bd^2/Nt$ exceeds 5.57, no compression steel is required. For this condition, it is more economical to use only tension steel.

Example 3. A column 12 by 22 in. (Fig. 2) is subject to compression and bending. The eccentric load is $N = 12{,}710$ lb with an eccentricity of $e = 53.9$ in. If the allowable concrete stress in compression is $f_c = 650$ lb per sq in. and $n = 15$, find the most economic design.

Using the information given in the figure, we get

$$\frac{f_c bd^2}{Nt} = \frac{650 \times 12 \times 400}{12{,}710 \times 62.9} = 3.9$$

and

$$\frac{d}{t} = \frac{20}{62.9} = 0.318$$

Using the chart, we find that the coordinates 3.9 and 0.318 are located on the line marked $k = 0.40$. Therefore a section in which $f_c = 650$ lb per sq in. and $k = 0.4$, will give the most economical design.

The steel stress in tension will then be using Eq. 3(b),

$$f_s = \frac{15 \times 650\,(1-0.4)}{0.4} = 14{,}625 \text{ lb per sq in.}$$

and the steel stress in compression, using Eq. 3,

$$f_s' = \frac{15 \times 650\,(0.4-0.1)}{0.4} = 7{,}312.5 \text{ lb per sq in.}$$

The steel areas become $A_s = 2.247$ sq in. and $A_s' = 1.970$ sq in., or a total of 4.217 sq in.

A Simple Method of Estimating Flood Frequency

By RALPH W. POWELL, M. AM. SOC. C.E.
ASSOCIATE PROFESSOR OF MECHANICS, COLLEGE OF ENGINEERING, OHIO STATE UNIVERSITY, COLUMBUS, OHIO

DURING the past thirty years a great deal of attention has been given to the development of statistical methods of estimating the frequency with which a flood of a given magnitude may be expected at any given point. Although most engineers would probably agree with Dean Thorndike Saville, M. Am. Soc. C.E., that none of the proposed methods offers more than "an approximation for the guidance of the engineer's judgment," it is important that this approximation be based on as sound a theoretical basis as possible. Also, other

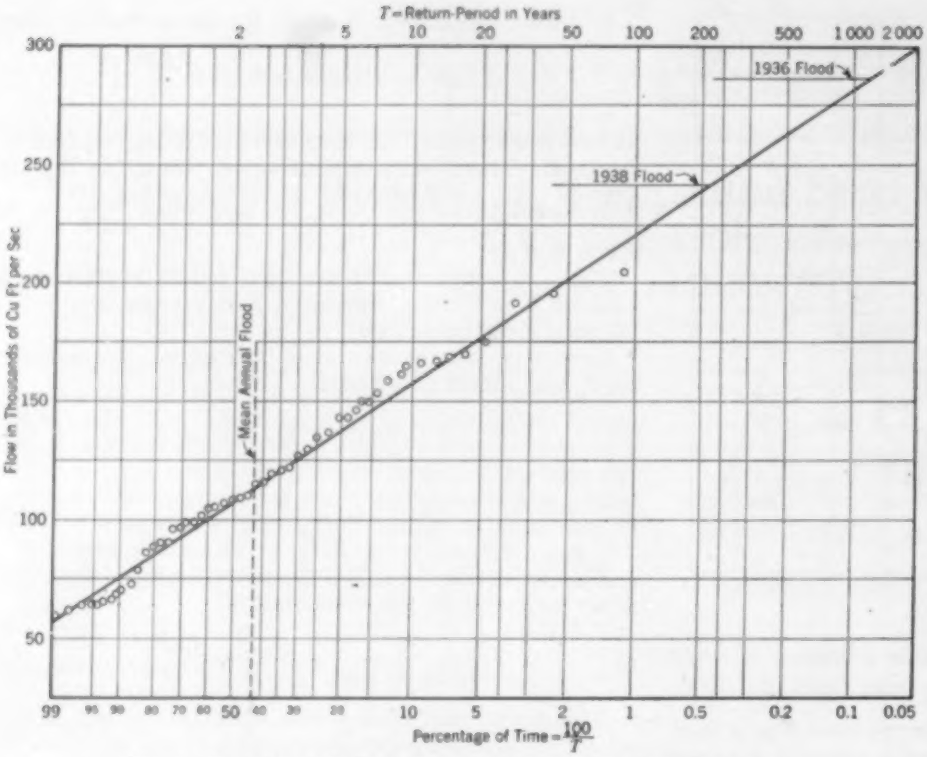


FIG. 1. RECORD OF ANNUAL FLOODS ON THE CONNECTICUT RIVER
At Hartford, for the Periods of 1843–1891 and 1893–1927

things being equal, the method which requires the least computation and which is most easily grasped by the non-specialist is to be preferred. And of two methods that may seem equally sound, the one that tends to give the larger values would appear to be the safer.

The writer believes that on these grounds the method proposed by Prof. E. J. Gumbel (*Annals of Mathematical Statistics*, June 1941, pages 163–190) is the best, especially since its application can be still further simplified, with no loss of accuracy, by the use of the plotting paper that will be described. By purely logical reasoning, based on surprisingly few assumptions, Professor Gumbel shows that $Q_m = Q_a + S\,(0.7797y - 0.45005)$ and $y = -\log_e\left[-\log_e\left(1 - \frac{1}{T}\right)\right]$, where

Q_m = the flood equaled or exceeded on the average of once in T years

Q_a = average of the "annual floods"

S = standard deviation of the "annual floods" = $\sqrt{\frac{n}{n-1}\left(\frac{\Sigma Q^2}{n} - Q_a^2\right)}$

y = function of stream flow defined by the preceding equations

n = number of years of record

ΣQ^2 = sum of the squares of the observed annual floods

Values of y for various values of T and $100/T$ are given in Table I. The latter is the "percentage of the time," that is, the percentage of the years in which the annual flood will be expected to be less than Q_m. The values are carried out further than necessary so that each user may decide for himself how many figures he wishes.

If a special plotting paper is prepared on which the horizontal lines are spaced uniformly and the distance between the vertical lines is made proportional to the values of y, the relationship between Q_m and T will plot as a straight line. Such paper is shown in Fig. 1. The zero value of y occurs at $100/T = 63.212$, and the other values listed in Table I are measured from this zero line and labeled with the value of $100/T$ along the bottom, and with the value of T at the top.

This paper may be used in at least three ways:

1. Values of the mean annual flood, Q_a, and of the standard deviation S, may be computed from the observed data. From Professor Gumbel's equations for Q_m and y, it can be shown that for $T = 2{,}000$, Q_m will be $Q_a + 5.476S$. This can be plotted at the right edge of the paper, and the value of Q_a plotted at the vertical line having $T = 2.376$ years, or $100/T = 42.96$. Any convenient uniform scale can be used for the Q's. Then draw a straight line through these two points. This will give the value of Q_m for any value of T up to 2,000 years. As a check, the observed values of all the annual floods may be plotted. For this the writer finds it preferable to use Horton's "recurrence interval," rather than his "exceedance interval" or Hazen's compromise. That is, in n years of record, the highest is taken as having $100/T = 100/n$, the next highest as having $100/T = 200/n$, and the next $300/n$, etc. The lowest, $100/T = 100$, cannot be plotted.

2. A second method would be simply to plot the observed data as just described and draw a straight line through it by eye, without computing Q_a or S.

3. A third method would be to compute Q_a but not S, and draw the line through Q_a and as near to the other points as possible. With a record of 50 years or more, it will be found that all three methods give practically the same results.

Plotted on Fig. 1 is the 84-year record for the Connecticut River at Hartford, given in one of Professor Gumbel's papers. For this the mean annual flood was 113,179 cu ft per sec and the standard deviation was 33,958 cu ft per sec. This gives the "2,000-year flood" as 113,179 + 5.476 × 33,958 = 299,133 cu ft per sec. The straight

TABLE I. VALUES OF y, A FUNCTION OF STREAM FLOW

$100/T$	T	y	$100/T$	T	y
99	1.0101	−1.5271	20	5.0000	1.4999
95	1.0526	−1.0972	15	6.6667	1.8170
90	1.1111	−0.8340	10	10.0000	2.2504
80	1.2500	−0.4759	5	20.000	2.9702
70	1.4286	−0.1856	4	25.000	3.1972
60	1.6667	0.0874	3	33.333	3.4914
55	1.8182	0.2250	2	50.000	3.9019
50	2.0000	0.3665	1	100.00	4.6002
45	2.2222	0.5144	0.5	200.00	5.2958
42.96	2.3276	0.5772	0.4	250.00	5.5195
40	2.5000	0.6717	0.3	333.33	5.8076
35	2.8571	0.8422	0.2	500.00	6.2136
30	3.3333	1.0309	0.1	1,000.0	6.9073
25	4.0000	1.2459	0.05	2,000.0	7.6005

line was drawn through this value and the mean annual flood, and then the individual annual floods plotted as has been outlined. (In the range from 90% to 20% every other point has been omitted to avoid crowding.) The fact that the points on this, as well as on a number of other records plotted by the writer, lie so close to the

straight line, convinces him that Professor Gumbel's theory accords well with the facts.

The extraordinary floods of 1936 and 1938 are indicated on Fig. 1 although they were not included in the period of record. If they had been, the line would have been steeper and the T's for these floods somewhat less, but even then the 1938 flood would have had a frequency of at least 100 years, and the 1936 flood one of about 500 years. Since both these floods far exceeded any others in the preceding 300 years, it is probable that the 1938 flood has a frequency of about 150 years, and the 1936 flood one of about 700 years.

Attention should perhaps be called to the fact that any statistical estimate based on a short record is untrustworthy, while a long record will probably include old records less accurate than the more recent ones. Also, our estimates depend primarily on the largest observed floods, which will almost certainly be the least accurate because based on extensions of rating curves beyond any actual gagings. Therefore there is small hope that our estimates will have a probable error of less than, say, 10%. And now that so many rivers are subject to artificial regulation, data on former unregulated flow must not of course be mixed with figures for the regulated flow.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Method for Determining Diagonals of Multi-Sided Polygons

To the Editor: Recently the writer had occasion to determine the number of diagonals of a polygon of so many sides that it was impracticable to do so by inspection. With a little thought, an expression was developed, $n\frac{(n-3)}{2}$, which gives the number of diagonals of any polygon of n sides. The writer has not seen this expression in any text, and thought it might be of interest to readers of Civil Engineering.

An interesting application of this formula is for the determination of the number of straight lines required to be drawn to connect all of a given number of points, n. This, of course, will be the sum of the sides and diagonals of a polygon of n sides, or $n + n\frac{(n-3)}{2}$. In case the polygon thus formed is re-entrant, some of the diagonals will lie wholly or partly outside the figure.

C. K. Harvey, M. Am. Soc. C.E.
Office Engineer, County of Allegheny Department of Works

Pittsburgh, Pa.

Emergency Specifications for Reinforced Concrete

Dear Sir: In the national emergency specifications for reinforced concrete, the allowed extreme fiber stress in compression for flexural members has been reduced from $0.45f'_c$ to $0.35f'_c$ with a maximum of generally 900 lb per sq in. According to the report on these specifications, which was published in the January issue of Civil Engineering (pages 63 and 64), the purpose of this change was to save reinforcing steel by requiring the use of larger structural sections.

The reduction in the allowable stress on concrete impels me to make the following comments:

1. If a designer is forced, in particular cases, to use a shallow section, the comparatively low allowable concrete section may result in compressive reinforcement, not needed at all according to the peacetime code, or in a greater amount of compressive steel than required by the latter code.

2. The decreased concrete stress of $0.35f'_c$ also enters into the formula (28), Section 710, which deals with combined axial and bending stress of columns. For a given column section and a certain loading condition, the wartime code may require, say, $1^1/_2$% of steel; whereas, according to the peacetime code, 1% would be sufficient.

3. If an existing building has to be checked for a new loading condition resulting from alterations or extensions, would any engineer want to alter a foundation already in place, because the concrete stress of the mat exceeds 900 lb per sq in.?

In all these cases there would be not a saving but a waste of steel.

It seems to me that a better way to save steel would have been to put a limit on the ratio of reinforcement to the effective section—a limit that the designer would be allowed to exceed only upon special permission. This would have served the purpose of conserving the supply of reinforcing steel without such inconsistencies as those mentioned above.

Robert V. Hauer
Structural Engineer

Detroit, Mich.

The Engineer as an Originator of Words

To the Editor: The engineer is really a concocter of words and ofttimes a creator of words. For this reason, when a condition, process, or service is given a name the words used should be well chosen.

The term "sanitary engineering" used to designate an endeavor does not seem right since the word "sanitary," according to Webster's Collegiate Dictionary, is an adjective and means, "of or pertaining to health; hygienic." From the definition, then, sanitary engineering means clean engineering. The term "sanitation engineering" seems more accurately to describe the branch of engineering, in which problems of sanitation are dealt with.

From an analysis similar to the foregoing, it seems that the following terms might well be used: Hydraulics laboratory in place of hydraulic laboratory; hydraulics engineer or hydrolician in place of hydraulic engineer; and sanitation engineer in place of sanitary engineer.

Douglas K. Jones, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering
University of Utah

Salt Lake City, Utah

Some Amusing Malapropisms

Dear Sir: In the November issue of Civil Engineering is a rather pleasing malapropism—"training in the several sciences indigent to the field of sanitation." A better one appears in a book on the economics of bridgework of twenty odd years ago: "In a few cases . . . the structure has been erected by a strident gantry traveler." And the index to another well-known work on bridges by the same author is most amusing. The reader seeks in vain for "tension," "shear," or "stress," but under "V" he finds "vain efforts of engineers to compromise with grace by ornamentation." To find a reference to working stresses, he must look under "intensities."

One of the classic howlers was perpetrated by a former Secretary of the Navy. Speaking of the *Vaterland*, rechristened the *Leviathan*, he said: "On examination, the complete report by Captain Jessop will show other acts of sabotage, such as the removal of the propeller shafts, which would have permitted the seepage of tons

of water into the hull of the ship and thereby cracked in the high-pressure cylinder."

In 1931 the president of a well-known railway organization cheered us by the following: "It [the automobile] has been a large factor in our unemployment situation and should be studied to prevent a recurrence."

In the specifications for the Detroit Windsor Tunnel one reads "Drain piping in and about the pump room to be supplied by the subcontractor whether entirely buried in concrete or not."

The Intercolonial Railway in its 1904 specifications was guilty of a most exacting clause, if taken literally: "The effective length of spans will be the distance between the centers of gravity of end posts, and the centers of end shoes or end bearing plates must coincide therewith."

The Dominion Government, in its 1901 Bridge Specifications, has a Section 180 which reads: "All material, which, subsequently to the tests at the mill and to its acceptance there, during manipulation, in the shops under shears, punch, etc., which shows it is not of uniform quality, as herein specified, and also hard spots, brittleness, cracks and other defects are developed; such material shall be rejected."

In specifications for the Fredericton Highway Bridge, one learns that "Traffic is now being carried on over the existing gap to be replaced by these two steel superstructure spans by means of a pile trestle temporary bridge. . . ."

C. M. GOODRICH, M. Am. Soc. C.E.

Walkerville, Canada

Society Dues as Tax Deduction

TO THE EDITOR: In the January number, under the title, "Economy Despite High Taxes," I note your statement that Society dues are a proper deduction from taxable income.

In 1941 the Internal Revenue Office at St. Louis, Mo., ruled that Society dues are not deductible unless one of the requirements for holding a position is membership in the Society. It was explained that in the case of a mechanic who was required to be a member of the union in order to hold a job, union dues would be properly deductible; but in the case of a civil engineer dues paid to the Society would not be deductible unless the employer of the engineer demanded that he be a member of the Society.

At that time the school teachers were said to be objecting strenuously to this ruling and had received some encouragement in having it changed.

St. Louis, Mo.

JOHN B. DEAN, M. Am. Soc. C.E.
Division Engineer, Supply and Purifying Section, St. Louis Water Division

[*Editor's Note: This St. Louis ruling is contrary to the usual interpretation. A popular guide on income tax matters has this to say: (1) "You may deduct . . . dues paid to labor unions or trade associations and professional societies"; and (2) under "Possible Deductions" are included "contributions and assessments paid to Chambers of Commerce and professional associations and made for business purposes." Many members have been permitted to deduct Society dues as a professional expense, and with entire propriety, it is believed.*]

Rodman on the Run

TO THE EDITOR: Following my brief studies sponsored by the government to fit me for one of the lower positions in a field party, I have recently been assigned as rodman for a precise leveling party in Florida. Readers of CIVIL ENGINEERING may be interested to hear of my first experiences and impressions.

For a few days the work was physically tough, but I am now getting used to it. The whole problem is team work—speed. We run from 10 to 13 to 18 miles of levels per day—a speed due in part to the fact that Florida is pretty flat country. The limit between succeeding set-ups is 300 m (approximately 1,000 ft), or 500 ft between gun and rod. Thus on cloudy days or early in the morning we run a mile every 6 set-ups, or in about 15 minutes. On hot afternoons, depending on the amount of refraction, it may take 13 set-ups or more.

We do not have to bother with recording the H.I.—just take the sum of the front and rear differences. I timed our observer, Charles Thompson, somewhat as follows: he gets off the truck, sets up the instrument, which has been carried by the check recorder, and reads the front and back of the rear rod in $1^1/_2$ minutes. Then he turns and reads the front rod in 1 minute. During this minute the rear rodman has to "hot foot" up to the instrument to get on the truck, whatever the distance required.

We all climb aboard the rear bumper of the truck and ride to the next set-up, located by a pacer who keeps ahead of the party all day. On arrival I hop off and hustle up the road a distance equal to the new backsight, where I hammer in a 15-in. iron pin and set the rod for the foresight. It is sort of game of leap-frog with each rodman going ahead alternately.

As you can see, if one man is slow or not ready he holds up the whole crew—one observer, one recorder, one gun carrier and umbrella man, one pacer and truck driver, two rodmen. I have never seen anything go so fast. One day in Virginia—before I joined—our party ran 21.6 miles. By the way, we are supposed to be the fastest party in the U.S. Coast and Geodetic Survey. But I suppose every party feels the same way.

ABE ANSON

Clearwater, Fla.

Forum on Professional Relations

CONDUCTED COLUMN OF HYPOTHETICAL QUESTIONS, WITH ANSWERS BY DR. MEAD

For several months Dr. Mead has been answering questions on engineering ethics in these columns. Question No. 1, which was published in the September issue of CIVIL ENGINEERING, *was answered in the same number, with no opportunity for discussion, as it was used simply as an example of the way in which questions would be asked and answered. Herewith Dr. Mead gives his opinions on Question No. 5, which was announced in the December issue: " 'A' owned a mining right, which he considered valuable but which he was unable to develop on account of lack of capital. 'B' was employed by a mining company which was anxious to acquire 'A's' rights but pretended indifference, hoping that this would cause 'A' to be willing to sell at a low figure. 'A' approached 'B' and told him that he would give him a certain sum of money if he would persuade his company to buy his rights, for a stated sum. 'B' knew that the company would be glad to obtain the rights at this figure. Was 'B' justified in accepting a commission from 'A'?"*

Every man owes loyalty to his employer. He should receive his compensation from such employer only, unless by a satisfactory arrangement with him he is permitted to do extra work, outside his regular hours of employment, for extra compensation.

If "A" is willing to pay "B" for selling "A's" property, evidently he would be willing to sell the property at the given price less the fee offered "B." However, if "B" accepts such fee he is to all intents and purposes robbing his employer of the amount of compensation he receives, unless he has undertaken such proposition for his employer with his full knowledge and consent that he is entitled to receive a direct compensation from "A" for such work. In this case "B" is acting as an agent rather than as an employee for his employer.

D. W. MEAD, Past-President and Honorary Member Am. Soc. C.E.

Madison, Wis.

Similar problems of professional relations will be treated by Dr. Mead each month. Next in sequence, for study and written discussion by members until March 5, with answers in the April issue, will be the following:

QUESTION NO. 7: *In a certain large corporation which employs many men, it is the practice of the superintendent and other officials of the company to have their automobiles overhauled and repaired at the company's repair shop, and to have more or less work done at their homes by the company's men and on the company's time. Should it be considered bad practice if the workmen made small tools and other things for themselves on the company's time and from the company's material?*

SOCIETY AFFAIRS

Official and Semi-Official

Ezra B. Whitman Heads the Society for 1943

STRANGELY ENOUGH most men, and engineers are no exception, like to look older when they are younger and younger when they are older. As will be self-evident, our new president, Ezra B. Whitman, certainly enjoys the second of these gratifications. But in his case, appearances are deceiving; he is older, and according to his friends tougher, than he looks.

His Christian name, too, might be misleading, suggesting a biblical character with a long beard. But he likes to be "Ezra" to his friends (he is the fifth of a series of seven in his family history), and "Major" to the others. The latter title is a reminder of his considerable activity in World War I.

He was born in 1880 in Baltimore, where he still lives. Following graduation from Cornell University, he took work at the Medical College in New York City, specializing in bacteriology and the chemistry of water supply. He and his partners, by the way, are steeped in Cornell lore and Cornell spirit. He knew on entering college that his home city would shortly embark on a large design and construction program for sewers, storm-water drainage, and sewage treatment and laid out nis courses accordingly. This program got under way after the great Baltimore fire. Meanwhile, young Whitman had had considerable experience as partner in the firm of Williams and Whitman in New York City, a relationship he assumed at the ripe old age of 22.

As a division engineer of Baltimore's Disposal Division, he had charge of a sanitary laboratory and pilot plant, from which he evolved the Back River Disposal Works, an advanced type of trickling filter plant. In this design he had to satisfy an eminent consulting board consisting of Rudolph Hering, Frederick P. Stearns, and Samuel M. Gray. After two years of design and three of construction, operation began in 1901.

EZRA BAILEY WHITMAN

He then left this work to become chief engineer and president of the Water Board of Baltimore. In 1914 he became associated with the late John E. Greiner, Hon. M. Am. Soc. C.E., under the firm name of Greiner and Whitman, and in 1916 he opened the Baltimore office of Norton, Bird, and Whitman, engineers. Then the war intervened. Among other responsible Army tasks he completed the construction of Camp Meade as constructing quartermaster. After the war he rejoined his engineering firm, which continued until 1925, when it was reorganized into the present Whitman, Requardt, and Smith. Many Society members who attended the well-remembered Baltimore Meeting in April 1941 will recall with pleasure the housewarming held at the new quarters of this firm in its own building on St. Paul Street.

Incident to his consulting work, Major Whitman has filled a number of important offices, some honorary but most of them laborious. For six years he was a member and later chairman of the Maryland Public Service Commission, being the first engineer appointee. During the same period he was chairman of the Baltimore Commission on Efficiency and Economy. He was also a member of a similar commission in Pittsburgh. There was also the celebrated Board of Engineering Review, retained by the City of Chicago in 1924 to advise regarding lowering of the Great Lakes level; of its 28 members Whitman was the youngest. In 1939 he was appointed chairman of the Maryland State Roads Commission, which position he still holds.

Thus his eminence in the consulting field and in public service is readily established. Not that any further proof is needed, but merely as a matter of interest it can be added that the generous walls of his office are literally covered with certificates, diplomas, and "shingles." Among others is one designating him as a real Kentucky Colonel, believe it or not. On the occasion of the house-warming previously mentioned, he took a lot of good-natured ribbing on this point. On the same occasion, another of his attainments was brought out—his fondness for old and sentimental songs, for which he has been called a "sucker." He knows the words and tunes of every song popular at the turn of the century. Of his associates on the Board of Direction only Director Howard, VicePresident Burdick, and Treasurer Trout can offer serious competition.

In his youth he was quite an athlete, being a member of the baseball and football squads at Cornell. He grew up with a large number of brothers, cousins, and chums who were wont to visit his grandfather's home. So he got accustomed to "rough-housing" and to taking care of himself. He still has that ability, as his partners learned to their chagrin when in a moment of exuberance they attempted to put him out of a room.

As a favorite student of Dean Fuertes, he heard many of the fine pieces of advice the "Old Mogue" gave to his students. He profited from two items especially. The Dean used to recommend that the first money a graduate earned should go into a dress suit so that he would be equipped not only for business but for social functions. Secondly, he advised his students not to marry too early, not until they could support three; for, said he, "Rest assured you will have three to feed shortly after you have two."

One attribute will serve him well in his presidency—he sincerely likes people. Yes, and he likes to dance, not only the old-fashioned steps but some of the modern ones, too. His open coun-

tenance gives such an impression of trustfulness that even a hardened crook would hesitate to presume on his credulity. Actually he knows his way around. And he has plenty of courage both mental and physical. He will face a hard fact or stand behind an error of his associates. In a strange city one of them became involved in a dispute and was threatened with bodily harm when he left a building. Major Whitman could easily have avoided being involved, but instead he stayed right there, taking off his glasses so as to be prepared for trouble.

While remembering books and even page references, he is apt to forget and leave his pajamas in a hotel or his brief case in a taxi. He always gets them back. One time at a Society Annual Meeting he took Art Dyer's dress trousers home with him. Obviously, neither trousers matched their new possessor, and each got the surprise of his life when next he wanted to dress up for the evening.

In golf Mr. Whitman is what is known as a "money-player." He is always fairly successful, but best when there is a hot contest on. He does not get rattled no matter how loud the raillery, or how critical the gallery.

Some would call Ezra Whitman lucky. He is lucky in the sense that he is not unlucky. In solving a problem he will take all the several steps necessary and not jump from premise to conclusion. His judgment, therefore, is sound, and he makes few serious mistakes. So he has had good success, in his professional work and likewise in his associates. And he has been happy in his family life, where his three children have continuously looked up to him, as well they might. His two boys attended Cornell and, contrary to the usual experience, they both elected to become members of his fraternity.

In Society matters Major Whitman has maintained a continuous interest, both locally and nationally. He was Director from District 5 for one term, 1923–1925, and so is familiar with his new duties. He faces a critical year, but difficult situations are no novelty to him. This is fortunate for the Society. All that anyone could ask and the least that anyone who knows him would expect is that he will bring to the organization the same industry, judgment, and personality that have made him an outstanding success in engineering practice.

The Society's Ninetieth Year

Text of the Annual Report of the Board of Direction for the Year Ending December 31, 1942, Omitting Statistics

ON NOVEMBER 5 last, the Society modestly celebrated its ninetieth birthday. Our nation was at war and no elaborate function was planned because so many members of the Society, nearly 75% of the total membership, were known to be intensively engaged in the war effort in one way or another. However, the November issue of CIVIL ENGINEERING devoted the major part of its Society news section to various events in the life of the Society.

The year 1942 has been devoted largely to the acceleration of the war effort. This Annual Report, therefore, tells briefly of some of the Society's war activities and concludes with the usual statistics which seem necessarily to form a part of any summary of the year's work and progress.

PARTICIPATION IN THE WAR EFFORT

The extent to which members of the Society have been engaged in the war effort may be gaged somewhat by a postcard questionnaire sent to 17,700 members. Although it was expected that some of these cards could not be delivered, or if delivered could not be returned from overseas, the response was astonishing in that 76.2% were returned. Three general questions were asked: "Are you in the Armed Services? Were you engaged on war projects or industries on August 1, 1942? Were you engaged on August 1, 1942, in official activities growing out of the war?" From the returns, it appears certain that approximately 3,000 members were in the Armed Services and that nearly 8,500 were engaged in civilian capacities in the design and supervision of war construction. Some 2,000 others, it appears, were aiding in civilian defense, selective service, rationing boards, etc.

Of those in the Armed Services it developed that 94% were commissioned, the greater part in the Army and Navy. As for those giving full time to the design and supervision of the construction of camps, training centers, airfields, drydocks, shipyards, etc., a somewhat disconcerting feature was noted; namely, that probably between 4,000 and 5,000 of the Society's members thus engaged appear to be destined for some degree of unemployment in 1943, when this type of construction in the United States decreases.

It would be impracticable to note all the demands that have been made on the Society's staff, to assist in this or that phase of building up the Armed Forces. Particularly appeals have been received for cooperation in securing officers for the construction units of the Army, the Navy, and the Marines. Many official contacts made by Society committees, its officers or staff, with responsible officials of the government on other matters also have resulted in the fulfilment of war needs. In consequence, it has been necessary to curtail the work of many of the technical committees as compared with that of normal times. Thus, while the theoretical advancement of the art of engineering in the civil engineering field has suffered somewhat, its practical application has advanced enormously. This advance has been reflected by papers presented and discussed at the Society's meetings and subsequently published, dealing especially with new devices and methods for securing speed in construction, and with the use of substitutes for essential metals. The four Society meetings held this year, in the Southeast, the Middle West, and that at Niagara Falls, Ontario, jointly with the Engineering Institute of Canada, have been devoted to topics selected to be of help in the winning of the war.

CIVILIAN PROTECTION IN WARTIME

Following the establishment, in 1940, of a National Committee on Civilian Protection in Wartime, local committees were formed in almost every community of fair size. To and through these local committees official and collected data have been continuously transmitted. Many members of these local committees have been officially designated advisers on technical matters by the several federal, state, and municipal agencies. Special capability has been thus recognized in the fields of sanitation, structures, traffic, power, and evacuation. During the year, 120 different items of information were distributed to all local committee members and other local officers and to a further selected list of about one hundred, including many non-members of the Society. The National Committee has established the closest cooperation with the OCD organization in Washington, to mutual advantage.

THE WASHINGTON OFFICE

As the Washington Office was opened in November of 1941, this is the first time that comment covering a full year of its operation can be made. It has performed many services through the member of the staff stationed there—Hal H. Hale, M. Am. Soc. C.E., and his secretary. Primarily its purpose is to keep the Board of Direction informed of what is going on in Washington as to matters affecting civil engineers. It is not a lobby. Contacts have

Members Under Arms Profit by Special Society Privileges

Many younger Society members in the armed services are now entitled to special considerations in the matter of dues. For those who may have missed the previous announcements, a repetition of the action of the Board of Direction at its October meeting is given as follows:

"Cancellation of 1943 dues is hereby extended automatically to all those members of the Society in the armed services of the United States who are Selectees; and, upon request for such cancellation, to those commissioned officers receiving base pay of $2,400 or less. Those who receive this exemption will continue to be listed as members of the Society and have prior unpaid dues canceled; and those who are Corporate Members shall retain their voting rights. However, no publications except CIVIL ENGINEERING are to be forwarded to those thus exempted."

been established, however, with several members of the Congress and with many executives in the various federal agencies, by whom, it is satisfying to record, these contacts have been viewed as helpful. In many instances the function of the civil engineer and his particular capabilities have been made known where they were not formerly understood. Mr. Hale has assisted in the drafting of contracts, the establishment of fees, and the interpretation of various executive or department directives. Information thus gathered has been published in CIVIL ENGINEERING or distributed to the officers of the Society's 64 Local Sections or to individual members upon inquiry.

Employment Conditions

Beginning March 1 last, a member of the staff, Howard F. Peckworth, M. Am. Soc. C.E., was assigned to the study of unsatisfactory employment conditions among engineers, particularly employer-employee relations, following the recommendation of a newly authorized Committee of the Society on Employment Conditions. After making a careful study of federal legislation affecting hours, wages, and conditions of employment, he traveled some 14,000 miles investigating the alleged unionization or pressure groupings of engineers, subsequently reporting his findings to the Board of Direction. In consequence he was instructed to be of help, wherever practicable, in the settlement of engineer employer-employee difficulties. Several articles written by him, or secured by him from federal officials, treating of the rights and privileges of employees and of employers, have appeared in CIVIL ENGINEERING.

As a result of definite requests from engineer employees, or engineer employers, he has acted as a conciliator or adviser in seven instances. In this connection he has traveled some 7,000 miles and has come into official contact with the highest representatives of the Army, Navy, U.S. Conciliation Service, and National Labor Relations Board.

His general observation is that engineers do not wish to affiliate with organized labor but that they do desire some form of group organization to assist them in perfecting salary, hours-of-work, and other employment conditions. In rendering advice to just such groups in Arizona, California, Florida, Illinois, Kansas, and Louisiana, he has traveled another 9,000 miles.

Membership

Membership in the Society increased to 18,354 on December 31, 1942, another all-time high. The net increase for the year, 916, is the largest in any year of the Society's history. This net increase, however, does not give, of itself, a clear perspective of the interest, or perhaps it may be called, the esteem, in which the Society is held. The net increase is a combination of the admissions and the severances, of which the larger percentage is by death. The number of applications for admission and for transfer from one grade to another affords, perhaps, a clearer picture of the values seen in Society membership. In 1942 a total of 1,940 such applications were received and examined in the usual meticulous manner, resulting in both approvals and declinations.

During the year a change in the Constitution was made in the interest of the Juniors. It had been observed that too frequently throughout the depression Juniors were unable to acquire, before the age of 33, the one year of experience in responsible charge required for advancement to the grade of Associate Member. In consequence, provision was made by this amendment that Juniors might retain that membership grade until reaching age 35, but that meanwhile, after the age of 32, dues shall increase at the rate of $2.50 per year for three years unless the Junior shall have previously transferred to the grade of Associate Member.

Finances

The increase in membership dues paid and a considerable increase in income from advertising in CIVIL ENGINEERING were largely responsible for a continued excess of income over expenditures, not withstanding certain approved financial concessions to members affected by the war. It was noted that many members of the Society, living outside the United States, including those in the Philippines, Guam, and other U.S. possessions, were in no position to communicate with the Society because of war conditions. These members have been placed on an "Inactive List." They are not billed for dues and do not receive the publications. Reduced dues, whereby the Society assumes the total difference between the respective rates of exchange, have been allowed to all members who are citizens of the British Empire. Exemption from the payment of dues has been granted automatically to all selectees, volunteers, and non-commissioned members in the Armed Forces, and, upon application, to all commissioned officers in the Armed Services having a base pay of $2,400 or less. CIVIL ENGINEERING goes regularly to all of those whose addresses are known.

Thus, at the end of its ninetieth year, the Society may be viewed as having reached the most successful point in its history. It has more members than ever before, more applications for admission and transfer, and greater financial resources. In facing the wartime period that lies ahead, it can count on all these favorable factors to enable it to carry on in service to the country and to its members.

Notes on the New York Annual Meeting

WITH BUT TWO short days, Wednesday and Thursday, January 20 and 21, for the business that has in past years required twice that time, members in attendance at the Annual Meeting found every hour of the days packed full. Representatives from every section of the country, more than 1,650, gathered to take active part in the business and technical sessions of the meeting. Nights were not long enough to hold the social gatherings which gave the visitors opportunity to meet old friends and make new ones.

Outstanding technical accomplishments were recognized Wednesday morning in the award of prizes, while at this same session services rendered to the profession during many years were acknowledged by certificates of Honorary Membership. The words of Rear Admiral Harris as he presented Rear Admiral Ben Moreell were most apropos. "In conferring this honor upon these men the Society honors itself." The responsible heads of military and civil organizations who received these awards were present for the occasion. Lt. Gen. Brehon B. Somervell, whose duties kept him away, was the only absentee, and he was represented by Maj. Gen. Wilhelm D. Styer, his chief of staff and personal friend.

Impressive indeed was the introduction of the new officers, who then assumed responsibility for the activities of the Society during the year to come. Their induction, with the presentation of the officer's gavel as a souvenir to retiring President Black, concluded the morning session.

Preceding the technical sessions of the afternoon, the members' luncheon was held in the Engineering Societies Building as usual. Simultaneously, at the Town Hall Club, students were welcomed to the Student Chapter Conference by Rear Admiral R. E. Bakenhuse. Even at this late hour the registration desk was kept busy by the arrival of members from a distance who had found lagging train service an insuperable obstacle to timely arrival.

Interest in the general meeting Wednesday afternoon was evidenced by the generous attendance which completely filled the auditorium. The remarkable construction schedule of the Alcan Highway which has amazed engineers and laymen alike was the subject of the session. Able discussion and numerous slides presented by Brig. Gen. C. L. Sturdevant and Col. Albert L. Lane of the Corps of Engineers, and by Thomas H. MacDonald and A. C. Clark of the Public Roads Administration, removed the doubts of many to whom construction of a 1,600-mile highway in three months had seemed impossible.

The Student Chapter Conference, held simultaneously, drew more than 136 young men from the metropolitan area. An award was made at this time to William Lynch, member of the Student Chapter at Newark College, for his paper, "Measures for the Control of Soil Erosion," prepared for the Metropolitan Student Chapter Conference Essay Contest.

Members and guests who attended the formal dinner held in the Grand Ballroom of the Waldorf-Astoria will remember that pleasant affair throughout the year. The high vaulted ceiling of this colorful banquet room resounded with the good humor and fellowship of those assembled. Following an excellent dinner, another proof that Oscar of the Waldorf is justly famous, a reception for the President and Honorary Members was held in the

1942 Board of Direction of the Society

Starting at near corner of table and proceeding clockwise: Charles Gilman Hyde, Director, District 13; E. P. Goodrich, Director, District 1; Lazarus White, Director, District 1; Charles M. Spofford, Vice-President, Zone I; Armour C. Polk, Director, District 10; Clifford G. Dunnells, Director, District 6; T. E. Stanton, Vice-President, Zone IV; Scott. B. Lilly, Director, District 4; E. E. Howard, Director, District 16; Gustav J. Requardt, Director, District 5; George B. Massey, Director, District 8; William N. Carey, Director, District 7; V. T. Boughton, Director, District 1; A. M. Rawn, Director, District 11; John W. Cunningham, Director, District 12; Ralph B. Wiley, Director, District 9; J. T. L. McNew, Director, District 15; Frederick H. Fowler, Past-President; William D. Dickinson, Director, District 14; George W. Burpee, Director, District 1; Charles E. Trout, Treasurer; Carolina Crook, Secretary to Mr. Seabury: George T. Seabury, Secretary; E. B. Black, Past-President; Charles H. Stevens, Vice-President, Zone II; Charles B. Burdick, Vice-President, Zone III; C. M. Blair, Director, District 2.

charming atmosphere of the adjoining foyer. Juniors and their guests joined the party for the dancing that followed.

The entire second day of the meeting, Thursday the 21st, was crammed with timely and vital technical papers presented at eight Division meetings. Virile prosecution of the war effort or proper provisions for post-war work was the objective of the speakers in every Division.

War Housing was the subject of a paper by Jacob L. Crane, Jr., of the National Housing Agency for discussion by the City Planning Division. Similarly the Post-War Housing Problem was analyzed in a paper by Harland Bartholomew, St. Louis city planner.

Army cantonments and mushroom cities near defense plants have given sanitary engineers opportunity to utilize the most recent developments in disposal practice. The papers presented were by J. L. Vincenz of the War Department, and by Richard H. Gould, Director of the Division of Engineering, New York City.

Different approaches to the analysis of problems in soil mechanics have provided opportunity for many careful studies of the basic characteristics of soil behavior. Professor Arthur Casagrande of Harvard proposed a soil classification for airfield projects. A spirited discussion followed, developing many valuable aspects of the subject. Gail Hathaway, of the War Department, discussed the design of drainage facilities for airfields at this meeting.

Attendance at the other morning meeting, that of the Construction Division, was so large that it became necessary to move into the main auditorium. Those present enjoyed hearing Charles E. Wuerpel, of the Corps of Engineers, and Adolph J. Ackerman, of the Dravo Corporation, who presented papers on "Studies of Cement and Concrete" and on "Assembly-Line Methods for Shipyards," respectively.

During the afternoon of this second day of the meeting, the Highway Division met to discuss soil-aggregate runway mixtures, a paper presented by Roy Crum, who is Director of the Highway Research Board. Gibb Gilchrist, Dean of Engineering at the Agricultural and Mechanical College of Texas, was the author of the paper on trends in highway engineering education.

The Structural Division held its session at this time, and was led in its discussion by A. J. Boase of the Portland Cement Association and Prof. Howard J. Hansen of the Agricultural and Mechanical College of Texas. Their papers covered recent developments in concrete and timber structures. Two of the Divisions in afternoon session had to move to larger quarters to accommodate the large attendance.

Throughout the meeting the work of the staff at Headquarters was a source of much interest to visiting members. Those who see for the first time the diversified activities of this group are amazed at the task involved in ministering to the needs of a membership which has passed 18,000. Many realized for the first time that during their visits in New York, the Society rooms are theirs to use as headquarters during their stay.

Alumni groups from colleges throughout the land met during the week for social affairs. Owing to the shortness of the meeting period, these dinner groups were encouraged to combine with the Dinner-Smoker at the Hotel Biltmore. This arrangement proved a happy one for the men in attendance and practically the whole floor of the hotel was thrown open for the affair. A fine dinner was followed by unusual and amusing entertainment and many a "gab-fest" was held by various congenial groups.

Although cut so short by the stress of the times, the meeting, according to general agreement, was most helpful and informative. The large attendance and keen enthusiasm noted on all sides confounded the advance predictions for this Annual Meeting. Gratifying, also, was the excellent showing of ladies and guests. Those who could take the time to attend were amply rewarded. To those on the committees responsible for the details of the events, should go the credit for a job well done. These committees, operating in the background, carefully fitted together the activities which filled the 48 hours during which the Society met in New York. Society and Division Committees, Board meetings, as well as other technical and social gatherings, rounded out the days which preceded and followed the Meeting proper. In all particulars the Ninetieth Annual Meeting was an outstanding success.

Ninth Annual Report of the Committee on Hydraulic Research

Hydraulic Studies Make Notable Progress

The Committee on Hydraulic Research functions under the auspices of the Executive Committee of the Hydraulics Division. The duties imposed at the time of its appointment in April 1934 were:

1. To determine upon a standardized system of symbols and nomenclature, for the use of all those carrying on model investigations in hydraulics.
2. To work along advisory lines to those carrying on model investigations in various hydraulic laboratories, bearing in mind the value of checking model work against full-size structures.
3. To encourage the preparation of papers relating to hydraulic research by those who are making investigations, and to find adequate and suitable means of publishing such papers.

Accordingly the committee organized to carry out a prearranged program:

(*a*) To prepare a manual on hydraulic models.

(*b*) To appraise the value of model studies in predicting prototype behavior.

(*c*) To institute a series of research projects in order to learn something more of the basic principles underlying all hydraulic phenomena; in short, to branch off from the empirical road—long traveled—into one of physical fundamentals in hydaulics.

Financial Aid by the Engineering Foundation. A number of research projects were selected and assigned to various directors of hydraulic laboratories who were appointed Cooperating Members of the committee. Funds were also requested from the Engineering Foundation to be used largely for expendible materials necessary to implement the work of research. The Engineering Foundation responded cheerfully with appropriations of $9,950 to date. These funds have had the effect of stimulating expenditures by the several institutions where the researches are carried on, in sum total many times that supplied by the Foundation.

Funds Supplied by the Society. In addition, the Society has appropriated funds for the general conduct of the committee's work, since 1938 from the appropriations to the Hydraulics Division. These grants have totaled $8,010.

Previous Reports. Preceding annual reports of the activities of this committee have been briefed and published in Civil Engineering as follows:

Vol. 7, No. 3, March 1937, p. 195
Vol. 8, No. 3, March 1938, p. 194
Vol. 9, No. 2, Feb. 1939, p. 109
Vol. 10, No. 3, March 1940, p. 185
Vol. 11, No. 2, Feb. 1941, p. 124
Vol. 12, No. 2, Feb. 1942, p. 113

Projects Aided by the Engineering Foundation

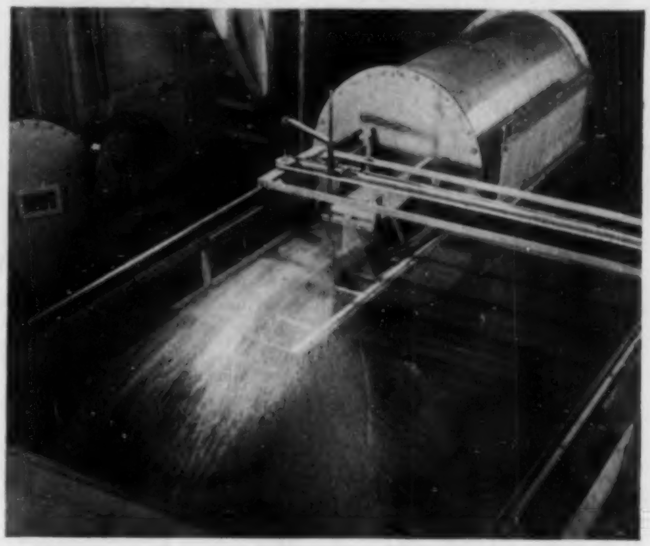
The present status of each research project aided by the Foundation is given below:

Project 67a. Conversion of Kinetic to Potential Energy, by A. A. Kalinske, Assoc. M. Am. Soc. C.E., Iowa Institute of Hydraulic Research. The recovery of velocity head attendant upon a reduction in velocity is a phenomenon of which comparatively little is known. An inquiry into the physical characteristics of such energy conversion was first undertaken by F. T. Mavis, M. Am. Soc. C.E., at the University of Iowa. A complete bibliography was first prepared and certain experimental work initiated. These experiments, conducted directly by Professor Kalinske, have been directed to finding the total kinetic energy of the mean flow and the energy of turbulence in conical expansions at a number of cross sections from above to well below the conical tubes. Expansions of $7^1/_2$, 15, 30, and 180 degrees total dilation have been used. Velocities and the paths of particles have been determined by analyzing the movements of particles of immiscible dyes injected into the water, as depicted on moving camera films.

The laboratory work has been finished and the preparation of the final report is virtually complete. A slight inkling of what is in prospect will be found in the paper, "Relation of the Statistical Theory of Turbulence to Hydraulics," by Professor Kalinske, Transactions, Am. Soc. C.E., Vol 105, p. 1571.

Project 67b. Traveling Waves on Steep Slopes, by Harold A. Thomas, M. Am. Soc. C.E., Carnegie Institute of Technology, Pittsburgh, Pa. Waves that follow each other in succession down steep chutes or on the face of dams offer an approach to the entire field of wave phenomena of which we have but a limited knowledge. The practical applications of the results of this research project are many and of great importance in hydraulics. The laboratory work has been finished and the preparation of the resulting paper is in its final stages.

Project 67c. Phenomena of Intersecting Streams, by M. P. O'Brien, M. Am. Soc., C.E., University of California, Berkeley, Calif. But little laboratory work has been done on this project during the past year and no further work is contemplated for the



Equipment for Study of Flow at an Abrupt Open-Channel Enlargement ($F = V^2/gd$ Is Approximately 9.0) at Institute of Hydraulic Research, University of Iowa

duration of the war. A paper giving the results of the research in open intersecting channels which constitutes a final paper on that phase of the subject, has been published, as follows: "Flow Characteristics at Rectangular Open-Channel Junctions," by Edward H. Taylor, Jun. Am. Soc. C.E., Proceedings, November 1942, p. 1521. This paper is now open for discussion. It was found that there are too many variables involved for open channels. Further research therefore is being confined to closed intersecting conduits.

Project 67d. Curves in Open Channels, by Charles A. Mockmore, M. Am. Soc. C.E., Oregon State College, Corvallis, Ore. The final paper on this research project has been submitted and has been accepted for publication by the Society. It will appear in the February 1943 Proceedings under the title, "Flow Around Bends in Stable Channels," by Professor Mockmore.

Project 67e. Sedimentation at the Confluence of Rivers, by L. G. Straub, M. Am. Soc. C.E., University of Minnesota, Minneapolis, Minn. The experimental work on this project has been completed and considerable progress made toward assembling material for the final report.

Project 67f. Air Resistance to Flow of Water in Open Channels, by L. G. Straub, University of Minnesota. Experiments on this project have been made almost continuously since its inception and are still in progress under the immediate direction of W. W. DeLapp, Jun. Am. Soc. C.E. After considerable experimenting, fairly effective means have been devised for determining the proportion of air and water in the flowing mixture by sampling, which marks a decided step forward in this kind of research.

Project 67g. Simultaneous Flow of Air and Water in Closed Channels, by F. M. Dawson, M. Am. Soc. C.E., University of

Iowa. Experiments have been under way in the hydraulic laboratory for nearly 3 years. For one phase of the project a long pyralin conduit of rectangular section is used, that can be steeply inclined. Water is admitted and simultaneously air is blown with or against the stream. Both air and water flow are measured. Configuration of the interface between the two fluids is determined by measurements and photographically, and all characteristics of the resulting waves are studied.

During the summer of 1942 the apparatus for this project, with the consent of the Engineering Foundation, was turned over to the Navy for certain research work important to the war effort. That special investigation has been completed and the work for which it was originally designed is being continued.

The second phase of this project has to do with flow in vertical pipes such as drains in buildings where air may be admitted at each toilet, sink, or other fixture.

Project 67h. Critical Depth Weirs, by C. A. Wright, M. Am. Soc. C.E., Polytechnic Institute of Brooklyn, Brooklyn, New York. Work on this project has been suspended for the duration of the war owing to lack of personnel. Only preliminary results have been secured to date.

Project 67i. Supercritical Flow in Open Channel Transitions, by Hunter Rouse, M. Am. Soc. C.E., University of Iowa, Iowa City. The first phase of this project is a fundamental inquiry into the phenomenon of flow as water is discharged from the end of a flume or from a nozzle onto a flat surface, with one restraining boundary of varying forms. A subsequent phase will include the adaptation of the basic laws, if such are found, to the design of transitions between conduits of different characteristics. Experimental work has been under way for more than a year and satisfactory progress is reported.

PROJECTS NOT RECEIVING AID FROM ENGINEERING FOUNDATION

In addition to the research projects enumerated, there are a few other projects for which no financial aid has been requested other than for the minor clerical expenses covered by allotments from the Society.

The Nature of Hydraulic Friction, by Boris A. Bakhmeteff, M. Am. Soc. C.E., Columbia University, New York City. The effects of fluid friction are seen everywhere, but neither physicists, engineers, nor philosophers are as yet able to define the basic nature of the phenomenon. Among experiments contemplated and for which arrangements have been perfected is the characteristics of flow in the large outlet pipes of San Gabriel Dam in California at such high velocities that the Reynolds number reaches multiples of 10^7. Experiments will be made by the Los Angeles County Flood Control whenever storage and other conditions are favorable.

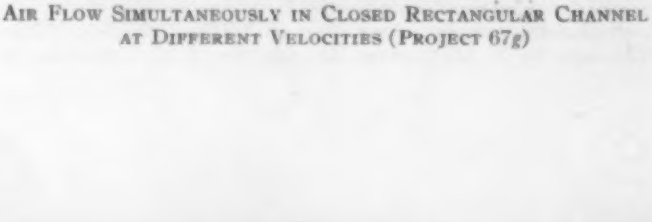
Cavitation in Hydraulic Structures. A subcommittee has been appointed to gather all pertinent information on this subject, to outline and supervise experimental work, and to prepare a final report. The members of the subcommittee (all members of the Society) are: John K. Vennard, chairman, New York University, New York City; Ireal A. Winter, Bureau of Reclamation, Denver; John C. Harrold, Office of the Chief of Engineers, Washington, D.C., and George H. Hickox, Director, Hydraulic Laboratory TVA, Norris, Tenn. One meeting of this subcommittee was held at Denver, Colo., November 27 and 28, 1942, where the future work of the committee was organized and task assignment made.

Manual No. 25, Hydraulic Models. The preparation of this manual has taken over six years. A mimeographed draft was first prepared and submitted to some 150 engineers for suggestions and criticisms. Following the returns from this the manuscript was extensively revised and submitted to the Society. It was accepted by the Committee on Publications and is now in process of being printed, publication being scheduled for January 1943.

Symposium on Conformity of Model to Prototype Behavior. The results of two years' work in securing papers culminated in a symposium in PROCEEDINGS in October 1942. Nine papers are presented, in each of which the conformity of model studies to actual prototype behavior is set forth for a variety of structures.

Abridged Translations. In PROCEEDINGS for November 1937 there were published abstracts of translations of foreign-language papers on hydraulics. The translating and abstracting were done under the direction of Donald P. Barnes, a cooperating member of this committee, by recipients of the John R. Freeman Traveling Scholarships. The object of these abstracts is to keep those interested in hydraulics somewhat abreast of the best foreign papers containing the results of original investigations and research. A second set of four abridged translations has been completed and is available for publication.

December 15, 1942 J. C. STEVENS, *Chairman*



WAVES CREATED AT AIR-WATER INTERFACE WHEN WATER AND AIR FLOW SIMULTANEOUSLY IN CLOSED RECTANGULAR CHANNEL AT DIFFERENT VELOCITIES (PROJECT 67g)

Double Savings

ARTICLES in Society publications are a real service to progressive engineers it appears, as illustrated by a specific instance just come to light. A paper in CIVIL ENGINEERING described an interesting and somewhat intricate piece of work successfully accomplished some months ago. Evidently it was read and noted for future reference by construction engineers.

Presently another equally difficult job was being considered. One of the junior engineers on this newer work suggested to the employer that the company which had done the work previously described ought to be able to be of considerable help, and quoted the CIVIL ENGINEERING article in support of his contention.

So it proved. The employer—in this case the Government—secured the contractor to handle the work. The results are of interest—a saving, over the previously contemplated method, of three months in time and $70,000 in cost. And the contract is what would be called today a small one.

It seems that it pays to follow the technical procedures of the moment as recorded in Society and other publications. Even more—it pays to put your experiences, the advances in the art, on record. All prospective authors please note.

The Engineer in Foreign Service

IV. With the AEF in Northern Ireland

By L. REID HENDERSON, JUN. AM. SOC. C.E.

Northern Ireland

WELL, I arrived at the "Emerald Isle" some time ago as a private in the great AEF of 1942. Now I'm a newly made sergeant trying to make good and hoping for a chance to end this war so I can get back to the good old U.S.A.

Nothing I have seen so far in Ireland or in the British Army can compare . . . with what America can offer either soldier or civilian. . . . America is something to be prized and is worth defending and fighting for. But America has a hard road ahead and must be prepared to sacrifice and suffer before victory is to be attained. You do not realize it now, but you will have a better appreciation of what war means and the task before us before the year runs out.

Ireland is beautiful with green fields and hedges, and the traditional winding lanes and green hills broken by the patchwork-quilt pattern of the cultivated land. Belfast is very busy during the day but so different from an American city. Goods are scarce, quality poor, and places of entertainment and good hotels and restaurants are hard to find. No matter how much money you have in your pocket you have to take what you can get and like it. The "Yankees" live, eat, and drink better than anyone else and have more money than they can spend.

Our present work has given me the opportunity to really meet and associate with the men and officers of the British Army. They envy our pay and our rations but smile with an air of superiority at our self-confidence and eagerness and with quiet dignity try to assert the fact of our inexperience. To them . . . England cannot

and must not fall or the whole world is lost. Defeats and disasters fail to shake this lofty attitude, as "Britain will not lose." Their courage and determination are beyond question.

The Englishman is surprisingly different from the American. His speech, his customs, his ideas are strikingly foreign to his American cousin. We amuse, astonish, and often shock them with our frankness and individualism. Our army is democratic and displays initiative in every rank; the British is well drilled, disciplined to European standards. Until victory,

Yours,

L. Reid Henderson

Editorial Confession

In publication work it is a good plan to give credit where credit is due. Such is the purpose of the following statement.

Editors are wont to work quietly behind the scenes—unseen. By and large, their efforts receive little credit; it is not needed and it is not desired. Occasionally the opposite is true, and they are indebted to others who are themselves uncredited.

This is the situation with respect to some of the fine accounts appreciative of the new Honorary Members of the Society as given in the January number. To complete this record it should be stated emphatically that much advantage was taken of the notes prepared by the following: for past-president Hammond, by John D. Galloway, Hon. M. Am. Soc. C.E., and T. L. Condron, M. Am. Soc. C.E.; for Commissioner Lawson, by C. M. Ainsworth, M. Am. Soc. C.E., J. L. Lytel, M. Am. Soc. C.E., and E. N. Noyes, M. Am. Soc. C.E.; for Admiral Moreell, by his sister, Caroline Moreell, and by Rear Admiral L. B. Combs, M. Am. Soc. C.E.; for General Somervell, by A. S. Tuttle, Hon. M. Am. Soc. C.E., and from *The New Yorker*, issues of February 10 and 17, 1940; and for Mr. Woodward, by James S. Bowman and E. Lawrence Chandler, Members Am. Soc. C.E.

In the present issue will be found an intimate account of President Whitman. Acknowledgment in this case is similarly made to Gustav J. Requardt, M. Am. Soc. C.E., long-time friend and associate of the new presiding officer. All these accounts are intended to be appreciative and at the same time human, in keeping with the characters and achievements of these notable engineers.

Electrical Engineer Wins Alfred Noble Prize

This year the Alfred Noble Prize has been awarded to G. W. Dunlap for his paper, "The Recovery Voltage Analyzer for Determining of Circuit Recovery Characteristics," which was published in the 1941 *Transactions* of the American Institute of Electrical Engineers. The presentation took place at the winter convention of the Institute, of which Mr. Dunlap is a member.

The Alfred Noble Prize was established in 1929 through a fund contributed by engineering and other friends of Alfred Noble, one-time President of the American Society of Civil Engineers, the American Institute of Consulting Engineers, and the Western Society of Engineers.

The prize is awarded annually to a young member of one of the Four Founder Societies or the Western Society of Engineers for a published technical paper of exceptional merit. At present Mr. Dunlap is development engineer in the laboratories of the General Electric Company at Schenectady, N.Y.

Another English Engineer Extends Welcome

In addition to several invitations from engineers in England, published in previous issues of Civil Engineering, another letter has recently been received by the Secretary. This is from S. Edward Meggitt, Assoc. M. Am. Soc. C.E., chartered structural engineer. His offer of hospitality follows:

"If any members of the Society (now in the Armed Forces) are temporarily resident in the Eastern Counties of England, I shall be glad to give them a hearty welcome if they will make themselves known to me."

Mr Meggitt's address is 319 Colchester Road, Ipswich, Suffolk.

Final Ballot on 1943 Society Officers

To the Ninetieth Annual Meeting — *January 13, 1943*
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1943 report as follows:

For President		
Ezra Bailey Whitman	3,967	
Scattering	7	
Blank	8	
	3,982	
For Vice-Presidents		
Zone II:		
Edgar Morton Hastings	3,950	
Scattering	2	
Blank	30	
	3,982	
Zone III:		
Thomas Radford Agg	3,946	
Scattering	3	
Blank	33	
	3,982	
For Directors		
District 1 (two to be elected):		
Reuben Edwin Bakenhus	3,947	
Dean Gray Edwards	3,946	
Scattering	5	
Blank	66	
Total votes registered	7 964	
Total ballots canvassed	3 982	
District 2:		
Charles Blaney Breed	3,951	
Scattering	4	
Blank	27	
	3,982	
District 6:		
Charles Francis Goodrich	3,951	
Scattering	2	
Blank	29	
	3,982	
District 10:		
Nathan Washington Dougherty	3,953	
Scattering	3	
Blank	26	
	3,982	
District 13:		
Fred C. Scobey	3,956	
Scattering	1	
Blank	25	
	3,982	
Ballots canvassed		3,982
Ballots withheld from canvass:		
From members in arrears of dues	12	
Without signature	89	
With illegible signature	4	
Total withheld		105
Total number of ballots received		4,087

Respectfully submitted,

Howard Holbrook, *Chairman*

Arthur S. Pearson	William H. Dieck	
Harry Wm. Stuber	Edward N. Whitney	
George L. Freeman	Joseph D. Lewin	
James McB. Webster	Bernard Gaber	
Bertram J. Ahearn	F. L. Greenfield	*Tellers*

Col. C. E. Myers Killed in Action

Just as this issue goes to press, word is received of the death of Col. C. E. Myers, M. Am. Soc. C.E., in action. He was prominent in Society affairs, having been Director from District 4 for the term 1936–1938, and chairman of the Highway Division for 1942. A more extended write-up of his activities will appear in the next issue.

News of Local Sections

Scheduled Meetings

ALABAMA SECTION—Joint meeting with Student Chapter at Alabama Polytechnic Institute at Auburn on February 26, at 7:30 p.m.

CENTRAL OHIO SECTION—Luncheon meeting at the Fort Hayes Hotel on February 18, at 12 m.

CLEVELAND SECTION—Luncheon meeting at the Guildhall Restaurant on February 1, at 12:15 p.m.

COLORADO SECTION—Dinner meeting at the University Club on February 8, at 6:30 p.m.

DAYTON SECTION—Luncheon meeting at the Engineers' Club on February 15, at 12:15 p.m.

INDIANA SECTION—Dinner meeting in Hurty Hall, Indiana State Board of Health Building, Indianapolis, on February 12, at 6 p.m.

IOWA SECTION—Meeting and luncheon at the Fort Des Moines Hotel on February 23, at 10 a.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on February 10, at 6:30 p.m.; dinner meeting of the Junior Forum at 5:30 p.m.

METROPOLITAN SECTION—Meeting in the Engineering Societies Building on February 17, at 8 p.m.; meeting of the Junior Branch on February 10, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on February 4, at 7 p.m.

MICHIGAN SECTION—Joint dinner meeting with the University of Michigan Student Chapter at Ann Arbor, on February 19, at 6:30 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Minnesota Union on February 1, at 6:30 p.m.

PHILADELPHIA SECTION—Annual social meeting on February 20.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on February 22, at 12:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings every Tuesday at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers' Club on February 16, at 5:30 p.m.

SEATTLE SECTION—Meeting at the Engineers' Club on February 22, at 8 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Knoxville, Sub-Section at the S. and W. Cafeteria on February 9, at 5:45 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on February 1, at 12:10 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on February 8, at 12:15 p.m.

VIRGINIA SECTION—Annual meeting at the Jefferson Hotel on February 12, at 6 p.m.

Recent Activities

ALABAMA SECTION

The twelfth annual meeting of the Section was held in Birmingham on December 11 and 12, with an attendance of over 100. The meeting was called to order Friday morning by W. N. Woodbury, president of the Section. Following the opening ceremonies, Harry W. Horowitz, of the Corps of Engineers, U.S. Army, discussed the role of the civil engineer in the war. At the noon luncheon W. H. Caruthers, former president of the Section, was toastmaster, and John W. Merryman, principal speaker. Mr. Merryman, who is on the engineering staff of the Bechtal-McCone-Parsons Corporation, spoke on the Birmingham aircraft plant. A talk on "Educational Training for Civil Engineers During the War"—presented by W. W. May, regional supervisor of the war training schools at Alabama Polytechnic Institute—was the feature of the afternoon technical session. Others who spoke were George J. Davis, dean of the engineering school at the university, and Comdr. John S. Leister, of the U.S. Navy. Friday evening there was a dinner and open meeting with the Birmingham Engineers Club and other local engineering groups. After-dinner speakers included J. M. Gallalee, professor of mechanical engineering at the University of Alabama; Col. A. C. Polk, Director of the Society; and Park C. Stone, special representative of the War Production Board for the Southeastern states. H. A. Davies, manager of the Virginia Bridge Company, acted as toastmaster.

On Saturday morning Donald C. A. du Plantier, professor of civil engineering at the University of Alabama, presented a paper on "Bridge Design During the War." He substituted for G. P. Willoughby, bridge engineer for the Alabama State Highway Department, who has been called into active duty with the U.S. Navy. The meeting closed with the annual election of officers. These are Thomas M. Lowe, president; J. B. Converse, first vice-president; A. R. Harvey, Jr., second vice-president; and R. T. Jennings, secretary-treasurer.

ARIZONA SECTION

An all-day session of the Arizona Section took place in Phoenix on November 28. At the business meeting in the morning John A. Carollo was elected president, and W. G. O'Harra, second vice-president. L. O. Fiscel automatically becomes first vice-president. Talks on the role of the university in wartime were then given by E. S. Borgquist, head of the civil engineering department at the University of Arizona, and Clyde Myers, director of engineering at Phoenix Junior College. At noon there was a joint luncheon with the Phoenix Engineers Club and the Arizona Association of Engineers, the speaker being A. F. Morairty, vice-president of the Central Arizona Light and Power Company. Mr. Morairty's topic was "Air Training and War Industries in the Salt River Valley."

Speakers at the afternoon session were R. A. Hoffman, chief of the division of bridges of the Arizona Highway Department, who presented a paper on timber bridges; Howard F. Peckworth, assistant to the Secretary of the Society, whose subject was "Employer-Employee Relationships in the Engineering Profession"; and James Girand, engineer for Leeds, Hill, Barnard and Jewett, who discussed "Army Camp Utilities." The group reassembled in the evening for a banquet and dance. During the evening Howard S. Reed, in his capacity as toastmaster, presented a certificate of life membership to R. V. Leeson.

CINCINNATI SECTION

An illustrated talk on "Asphalt—Its Sources, Grades and Various Uses" was the feature of the December meeting of the Cincinnati Section. It was given by A. H. Hinkle, district engineer for the Asphalt Institute, who discussed the latest developments in the use of asphalt for highway construction and maintenance, the construction of airports and cantonments, industrial plants, and in other fields.

COLORADO SECTION

On December 17 members of the Colorado Section celebrated Ladies' Night. The list of guests included Ezra B. Whitman, President-elect of the Society; Herbert S. Crocker, Past-President and Honorary Member; and Gustav J. Requardt, Society Director. All spoke briefly, and Colonel Crocker presented a certificate of life membership to Burton Robert Follansbee. Presentation of a similar certificate to Burton Lowther was deferred to a later date due to Mr. Lowther's absence. The principal speaker was R. G. Gustavson, dean of the graduate school at the University of Colorado, who discussed the difficulties and dangers confronted in high-altitude flying. Low atmospheric pressures and lack of oxygen combine to cause the so-called "bends," known to deep-sea divers, he pointed out. Dr. Gustavson also described the dangerous effects of the greatly increased gravitational force to which a flier is subjected when leveling off after a steep dive. These dangers, in addition to those originating from the enemy, should make us appreciate still more the excellent work our fliers are doing, he concluded.

The annual election of officers, held at this time, resulted as follows: Harry L. Potts, president; E. Warren Raeder, vice-president; and C. P. Vetter, secretary-treasurer.

Dayton Section

Members of the Dayton Section met on December 21 for a luncheon and the annual election of officers. C. J. Belz will be president; Charles H. Shook, first vice-president; Charles S. Bennett, second vice-president; and W. E. Keyser, secretary-treasurer. The principal speaker was Dr. Arthur E. Morgan, past-president of Antioch College and former chairman of the TVA. Dr. Morgan reviewed his recent book, *The Small Community, Foundation of Democracy*, in which he deals in detail with the rural sections of the country and the development of democracy in these small groups.

Georgia Section

On November 9 the Georgia Section held two joint meetings to hear Comdr. John S. Leister talk on the subject of the Seabees. At noon Commander Leister addressed a luncheon meeting of the Section and the Georgia Engineering Society, and in the evening he spoke again to a joint dinner meeting of the Section and the Atlanta post of the Society of American Military Engineers. Members of the Georgia School of Technology Student Chapter also attended the latter gathering.

Illinois Section

At the December meeting certificates of life membership in the Society were presented to T. L. D. Hadwen, Paul Hansen, and Langdon Pearse. Others in the Section similarly honored, but who were unable to be present, include H. E. Eckles, D. C. Fenstermaker, H. B. Fleming, W. A. Theodorson, A. M. Turner, and W. G. Zimmermann. A report on Society activities was given by C. B. Burdick, Vice-President of the Society. Others who spoke were W. V. Frame and E. G. Robbins, newly elected president and secretary of the Junior Section; and Lieutenant Harrison, of the Construction Battalions of the Navy. The annual election of officers resulted as follows: J. F. Seifried, president; Ralph H. Burke, vice-president; and C. R. Ege, treasurer.

Ithaca Section

A joint meeting of the Section and the Steuben Area Chapter of the New York State Society of Professional Engineers took place in Elmira on December 17. The technical program consisted of an illustrated lecture on "Bridge Building, Past and Present," by Joseph O. May. Mr. May is engineer in charge of the department of estimate and design in the New York office of the American Bridge Company. A dinner for 55 preceded the meeting.

Kansas Section

Speakers at the December dinner meeting of the Kansas Section—held in Topeka on the 11th—were John F. Harbes, engineer of planning for the Kansas Highway Commission; and Howard F. Peckworth, assistant to the Secretary of the Society. The former spoke on the necessity of planning for the future, while Mr. Peckworth discussed his findings in the field of unionization of engineers.

Kentucky Section

At the December dinner meeting R. E. Shaver was elected president; W. S. Todd, vice-president; and H. J. Sundstrom, secretary-treasurer. Following the business session the Hon. Ward T. Havely, mayor of Lexington and president of the Central Rock Company, spoke on "The Underground Mining of Limestone." Operations are conducted by room-and-pillar method at a depth of approximately 300 ft, each room being about 40 ft high, Mr. Havely pointed out. Although the present shaft was sunk from the ground surface downward, plans are now under way to drill a second shaft, beginning in the mine room and drilling upward to the surface. Because of the saving of over a hundred operating days per year (normally lost because of bad weather), better rock and the absence of dirt and stripping, production costs are lower than for surface quarrying. Mr. Havely's talk proved of special interest and stimulated one of the most active discussions of the year.

Louisiana Section

Each year the Louisiana Section awards scholarships, covering the current year's tuition, to outstanding civil engineering students at Tulane and Louisiana State universities. The Section now announces that these awards for the 1942–1943 school year have gone to George Arthur Seaver III, of Tulane, and to Charles S. LeBlanc at Louisiana State.

Metropolitan Section

"Construction of Graving Docks for the U.S. Navy by the Tremie Method" was the subject of discussion at the December meeting of the Metropolitan Section. The principal speaker was W. Mack Angas, captain, Civil Engineering Corps, U.S. Navy, who used both a model and moving pictures to illustrate construction details. Captain Angas stated that construction procedure for these docks has improved greatly in recent years and quoted a statement of the chief of the Bureau of Yards and Docks to the effect that the first dry dock at Pearl Harbor took six years to construct, while the body of the second was built in twenty months. The dock was completed two weeks prior to the attack on Pearl Harbor and accommodated ships for repair two days after the attack. Lively discussion, centering about the difficulties involved in this type of underwater construction, followed the presentation of Captain Angas' paper.

The Junior Branch of the Section has been enjoying semimonthly meetings. The session held on December 9 proved specially interesting, as Harold W. Richardson, Western editor of *Engineering News-Record*, described the building of the Alcan Highway. Acting as a war correspondent, Mr. Richardson was the first man to travel the entire length of the 1,700-mile route. By jeep, by command car, by truck, and on foot, he covered the road from Dawson Creek, B.C., to Fairbanks, Alaska, and was at the scene when the road was "holed through." Describing this one season's battle against the wilderness, Mr. Richardson asserted that the highway probably represented the greatest construction feat since the Panama Canal.

Northwestern Section

A symposium on "Engineering Problems Confronting the Twin-Cities Metropolitan Area" comprised the technical program on January 4. Those taking part were George H. Herrold, planning engineer for the St. Paul Planning Board; Dr. H. A. Whittaker, director of the Division of Sanitation of the Minnesota State Board of Health; and K. B. Rykken, statistician for the Minnesota Highway Planning Survey. The discussion was opened by Frederic Bass, professor of municipal and sanitary engineering at the University of Minnesota, who stressed the necessity for long-range planning to follow the establishment of peace.

Oregon Section

At the December meeting of the Oregon Section Vice-President Glenn W. Holcomb was elected president to fill the unexpired term of the late C. I. Grimm. A talk on "Principles of Soil Cement Treatment" was given by Bailey Tremper, materials engineer for the Washington State Highway Department. Carl Smithwick, of the Portland Cement Association, then showed two reels of motion pictures, portraying construction practices at two important air-bases, where soil-cement pavements were placed.

Philadelphia Section

Secretary Seabury was a guest at the December meeting and presented certificates of life membership to eight members of the Section. Following the presentation of the certificates, J. H. Carr, Jr., structural engineer for the Timber Engineering Company, Washington, D.C., was introduced. Mr. Carr traced the history of timber connectors, explaining that they were developed in Europe during and after the last war when steel for building construction could not be readily obtained. The National Committee on Wood Utilization of the Department of Commerce, in connection with the Forest Products Laboratory, made an extensive investigation of a great many of the European types of connectors and recommended the adoption of certain types for American use. The second speaker was Verne Ketchum, chief engineer of Timber Structures, Inc., who described the prefabricated timber structures using connectors that are made by his company. Mr. Ketchum then presented a number of slides showing the actual fabrication of the structures, which include single-span structures in excess of 250 ft.

Sacramento Section

The December 22d luncheon was preceded by a cocktail hour and followed by the Annual Christmas Jinks. Officers for the new year were also elected at this time, with the following results: John H. Obermuller, president; Frederick H. Paget, second vice-president; and R. Robinson Rowe, secretary. Speakers at the other regular luncheons included J. Burdette Brown, extension

specialist in irrigation at the University of California, who explained the efforts being made to inventory rural water supplies that could be utilized in case of an accident to the regular supply. On one occasion a film showing the historical development of aluminum was shown through the courtesy of the Aluminum Company of America.

St. Louis Section

At the annual dinner meeting of the Section, which took place on December 11, Lt. Col. L. B. Feagin was elected president for the coming year. Others elected were H. E. Freen, vice-president; D. C. Bowman, councillor; and M. Buchmueller, secretary-treasurer. Following the presentation of a certificate of life membership to John A. Lahmer, there were brief talks by T. R. Agg, newly elected Vice-President, and William D. Dickinson, Director from District 14. Both discussed the activities of the Society and commented on problems to be solved. A lecture, entitled "Our Professional Ancestors," concluded the program. This was given by Starr Truscott, chief of the Hydrodynamics Division of the Langley Memorial Aeronautical Laboratory. Slides, showing some of the almost incredible engineering achievements of the ancients, added to the interest of his talk.

San Francisco Section

On December 15 members of the San Francisco Section heard George A. Pettitt, assistant to the president of the University of California, speak on "Atom Smashing—Present and Future." Dr. Pettitt outlined the developments in atomic research that inspired the invention of the cyclotron, or atom smasher, and summarized the accomplishments of the cyclotron to date. These are (1) Transmutation of any element known to man; (2) creation in the laboratory of a vast array of new radioactive elements not found in natural form; and (3) production of a strong beam of neutrons as a secondary phenomenon during the bombardment of certain targets. His talk was concluded with a description of the new 4,900-ton cyclotron, which is now being built at Berkeley. Prior to the meeting the new life members were dinner guests of the Section, and were presented with certificates by Vice-President Samuel Morris. These members are Charles L. B. Anderson, Perry F. Brown, Frederick R. Muhs, William H. Popert, and Charles Moser.

The program for the November meeting of the Junior Forum consisted of talks by H. J. Ongerth and Herbert Crowle, both members of the Forum and both on the staff of the U.S. Engineer Department. The former discussed the effects of the war on sanitary engineering, while Mr. Crowle's subject was "The Civil Engineer and World Economics." The topic for general discussion was "The Place of Ethics in Wartime Employment Opportunities."

Utah Section

A talk on "The Davis County Flood Control Project" comprised the technical program at the December meeting of the Section. The speaker was W. J. Homan, senior engineer for the Division Office of the U.S. Engineer Office, who outlined the area of the Davis County Project on maps and discussed its topographic and hydrographic features. He pictured the composition and movement of debris flows and suggested possible solutions to the problem of these powerful masses. A plea to engineers to accept commissions in the Civil Engineering Corps of the U.S. Naval Reserve, was then presented by Lt. D. E. Carberry, procurement officer for the 12th Naval District. During the annual business meeting Joseph H. Young was elected president for the coming year, and Edmund B. Feldman, second vice-president.

A special luncheon was arranged on December 31 for the purpose of welcoming President Black. Following the luncheon, President Black discussed the Society's activities during the past year. "Engineers, and particularly American engineers, will be expected to take a leading part in restoring the war-weary world," Mr. Black concluded.

Virginia Section

On November 7 members of the Virginia Section gathered at Roanoke for their fall meeting. The meeting got under way in the afternoon with a business session, followed by a program of student papers on timely subjects. Those taking part were Cadets C. J. Bounds and R. B. Mountcastle, of Virginia Military Institute, and Cadet A. F. McElwee, of Virginia Polytechnic Institute. Then Franklin P. Turner, principal assistant engineer for the Norfolk and Western Railway, spoke on remodelling, enlarging, and providing improved facilities for operation of the Norfolk and Western yard at West Roanoke, Va. Mr. Turner stated that work on this project was started in 1940, completed, and turned over for operation early in 1942. As many as 2,500 cars have been handled at the yard in 24 hours, but the capacity is much greater. A dinner and social hour concluded the program. Dr. Mowbray Velte, formerly of the University of Calcutta, was the principal after-dinner speaker, his subject being "India's Problem Today." Other guests included Major Hobbs, a British tank expert assigned to duty in the United States, and Hal Hale, the Society's Washington representative. The program, which was arranged under the direction of Col. R. H. Marr, Jr., professor of civil engineering at Virginia Military Institute, attracted an attendance of over a hundred.

Student Chapter Notes

Case School of Applied Science

The Case School of Applied Science Student Chapter opened the fall term with a short business meeting on October 16. Following the meeting, Prof. G. E. Barnes, Faculty Adviser for the Chapter, gave a short talk on the advantages of Student Chapter membership to the incoming sophomores. He also explained the Berlin Dam project, which the group visited later in the month. The trip was arranged by Col. H. D. Vogel, of the U.S. Corps of Engineers, and Professor Barnes. The Chapter reports that the coming year promises to be unusually successful, and that the *Plumb Bob*, official Chapter publication, has four more pages than in preceding years. The *Plumb Bob* is issued several days in advance of each meeting and serves as a meeting announcement.

College of the City of New York

Weekly meetings have been enjoyed by the College of the City of New York Chapter during the past semester. The list of speakers for these occasions included Charles W. Cunningham, Faculty Adviser; G. Bailey, of the New York City Tunnel Authority; Waldo G. Bowman, editor of *Engineering News-Record;* W. B. Kane, engineer for the Portland Cement Association; L. E. Andrews, regional highway engineer for the Portland Cement Association; and Acting Assistant Secretary James E. Jagger.

Iowa State College

The Iowa State College Chapter, reports that the new school semester got off to a good start. The annual fall round-up opened a membership drive, and attendance at the various meetings has considerably exceeded last year's. Speakers at the later meetings included B. A. Whisler, assistant professor of civil engineering at Iowa State College, and Z. G. Hopkins, of the public relations department of the American Railway Association.

The class secretary comments, "Our meetings have been marked by a new feeling of cordiality among the members. A new system has been originated, whereby four members of the group are introduced by a short experience sketch (factual and humorous) at each meeting."

Newark College of Engineering

A talk on post-war planning—by President Cullimore, of the Newark College of Engineering—initiated the Chapter's fall season. A number of prospective members attended this session. Among the speakers addressing later meetings was Lt. Comdr. LaLonde, who discussed the civil engineer's place in the Navy.

Pennsylvania State College

On December 10 the Pennsylvania State College Student Chapter held its annual banquet in the Home Economics Building on the college campus. The guest of honor and principal speaker was C. G. Dunnells, Director of the Society. Frederick T. Mavis, head of the department of civil engineering at the college, also spoke, and Elwood Hendrickson acted as toastmaster. Mr. Hendrickson is president of the senior class.

Syracuse University

Several meetings were enjoyed by the Syracuse University Chapter during the past semester. Some of these sessions were devoted to business discussion and program planning. On one occasion Carl J. Chappell, soils engineer for the Portland Cement Association in New York City, gave an illustrated lecture on the subject of soil cement, showing its application to Army camps and airfields and county roads.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for March

Among the many engineering problems encountered in connection with the War Department's new Pentagon Building in Arlington County, Va., was the arrangement of a network of express and service roadways to handle the enormous traffic which this building would create. As the construction nears completion, Joseph Barnett, of the U.S. Public Roads Administration, will describe for readers of Civil Engineering the unusual features of this undertaking.

Huge cantonments in the West have involved the services of men in nearly every branch of civil engineering. In many locations the adequate disposal of sewage has given opportunity for the provision of unusual features for efficient operation. The description of equipment and operating procedure by A. H. Jessup in his paper, "Two-Stage Biofiltration Sewage Treatment Plant for an Army Camp" provides an interesting record of wartime planning and design in this field.

For many years the members of bridge trusses were pin connected at the panel points. For reasons of economy, tension members were generally forged-head eyebars. As riveted joints grew in popularity, use of these members was abandoned in favor of rolled sections which could carry the stresses distributed by the rigid connections. Most plants which once manufactured eyebars therefore destroyed their dies so that in the instances where it is still economical to use plate or bar tension members it is often necessary to make some other provision for the end connectors. Welded-head eyebars, described by Jonathan Jones, of the Bethlehem Steel Company, have proved their adaptability to this service. Tables and figures for the design of these bars form a part of his paper scheduled for the March number.

N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

"Now, gentle reader.... Excuse me, gentlemen of the Engineers Club, I'm going to take it easy tonite and watch the parade of the Guest Professors. Here's Professor Prior ready for the showdown on the box-in-a-box-in-a-box problem he posed last December. Professor Jenney will be here any minute now with a new teaser; he wanted to hoe his Victory Garden until the last moment. Fire away, John."

"Well, to summarize, my box problem reduces to the double inscription of rectangles. How wide is box C if it can be inscribed in box B and B can be inscribed in box A, which is 5 ft long, if $B + C = A$ in shape and area?"

"Impossible," commented Joe Kerr. "I spent an evening with scissors and an old telephone book and gave it up as hopeless. I think it's a myth, like Pandora's Box!"

"But her's still had Hope. Even if mine was filled with eggs and ham and bacon, there's room for hope."

"Joe might have done better a second night, particularly if he knew the discriminant for inscribability of rectangles, which is:

$$(c^2 + d^2)\,(a^2 + b^2 - c^2 - d^2) = 4cd(ab - cd) \quad \ldots\ldots(1)$$

where the rectangle cxd is inscribed in axb. Given any three of the four dimensions," continued Cal Klater, "and the fourth is determined, by a quadratic in a or b, or a quartic in c or d. I used that discriminant twice and got a quartic in the required side:

$$4x^4 - 100x^3 + 650x^2 - 1{,}625x + 1{,}250 = 0 \quad \ldots\ldots(2)$$

"Then, by cut and try, $x = 1.37$ ft, and the sketch shows the two arrangements of the boxes."

"Excellent, Mr. Klater," said Professor Prior. "Of course a purist would have found the solution of Eq. 2 algebraically."

"Which I did by Horner's method," said Ken Bridgewater, "getting $x = 1.3718903398$."

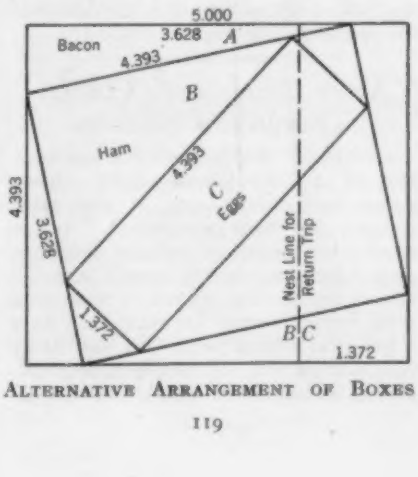
"No," contended Simon Poore. "Professor Prior must mean the Euler-Cardan method, which expresses the answer precisely in surds. Here it is, in substitution form to save time:

$$x = \frac{5}{12}\left[15 + \sqrt{69 - 3k} - \sqrt{138 + 3k + 6\sqrt{k^2 + 23k + 553}}\right]$$

where $k = \sqrt[3]{406 + 2\sqrt{41{,}337}} + \sqrt[3]{406 - 2\sqrt{41{,}337}}$."

"So I did, Simon. I recommend the purist method only as an exercise to enhance the beauty of short cuts. That coup writes 'finis' to the problem, Noah."

"Nothing I can add, except 'Thanks.' Here comes Guest Professor Jenney—just in time. Dick, tell us about your Victory Garden before you spring the new problem."



Alternative Arrangement of Boxes

"Not much to tell, Noah. Radishes, onions, peas, and turnips are up and the rest is all seeded, using every inch of my backyard. The yard, you remember, is square, with a square garage in the southwest corner. I had planned to lay out the whole garden in squares like the garage, but my wife wouldn't let me disturb the row of last year's chard, which is still thriving. So I curbed the chard in a plot a foot wide by 24 ft long and divided the rest of the yard in square plots, no two alike.

"I planted potatoes in the largest plot this afternoon. For a problem, the Club might figure the area of my potato patch and where it is."

"A peck of potatoes for every right answer?"

"No, a pint of potato bugs, and pick them yourselves!"

[Cal Klater was, chronologically, Claude W. West, X. Tracter (Benjamin Eisner), Richard Jenney, Frederick V. Pohle, and O'Kay (Otto H. S. Koch). Scoffers Joe Kerr will enjoy anonymity. Of the new problem, Professor Jenney adds, "Thanks, not apologies, to Dudeney."]

Engineering Art by Lili Réthi

On many occasions over the past few years, as in the present issue, we have been privileged to feature Miss Lili Réthi's drawings of civil engineering projects. It might be said that by Miss Réthi's courtesy we have had special privileges. Her drawings seem to have caught the spirit of the construction job, especially large and spectacular works, as built by civil engineers.

It will be recalled that at the time of the 1942 Annual Meeting, many members enjoyed an exhibition of Miss Réthi's work displayed in the Board Room at Society Headquarters. Those drawings illustrated architectural and industrial themes, it is true, but they also had a special appeal for civil engineers. It is of interest at this time, therefore, to know that her work is receiving recognition in artistic as well as in engineering circles—she is to have an exhibition at the Metropolitan Museum of Art in New York City, starting February 20 and continuing from four to six weeks. This, her third exhibit in New York City, is directly traceable to the success of the previous one in the Society rooms a year ago.

The coming exhibit, totaling 35 to 40 pictures, will illustrate particularly dry-dock construction. Some of the drawings are colored. Two series of sketches are included, one of dry docks illustrated in the 1942 exhibit and others of entirely new subjects. One of the latter, sketched on the job at an eastern Navy Yard, is shown on the current Page of Special

Interest. Illustrated are the final stages of work on the inshore end of a large dry dock. The walls and floor are already in place. The outshore end, however, is to be extended further in the next stage of construction. This is one of a number of original drawings which will appear in a portfolio to be issued privately, entitled "U. S. Naval Dry Docks."

"Civil Engineering" acknowledges its gratitude to Miss Réthi and to the construction company for the privilege of including this example of her art.

Professor Neare Interviewed

Confessions of Our Enigmatologist

WITH this issue of CIVIL ENGINEERING, "N. G. Neare's Column" begins its fourth year. Asked by millions,* "Who is that upstart, Neare?" the editors assigned this reporter to interview the old chap in his lair. So we did, feeling like Dr. Jekyll calling on Mr. Hyde.

"We suppose," we asked him delicately, "you call yourself an enigmatist?"

"Not at all," he protested. "I'm an enigmatologist."

"But an enigmatologist solves puzzles!"

"Right, and so do I. Granted that the Column represents me as an enigmatist, I concede only that I am a reluctant amateur. Solving puzzles is my lifelong hobby."

"Then why pretend to be an enigmatist?"

"Because of human desire for revenge."

"Revenge? On whom?"

"On me. Suppose the reluctant amateur assigns a tricky problem to the Engineers Club. The boys tear their hair for several sleepless nights. They want revenge. So they concoct trickier problems and fire them back."

"But, being an expert, you find the answers without any trouble at all?"

"We-e-ll, that's nice of you to think so. But look back thru the Columns and you'll find a few tough assignments—my revenge, maybe."

"This 'Engineers Club'—is it fictitious, or has it a prototype?"

"Fictitious, entirely. Instead of saying 'Now, gentle reader ...,' Noah uses the 'Club' as a familiar address to engineer-nuts like himself."

"And what manner of engineer is an engineer-nut?"

"That's best answered by statistics. Here's a table which compares the distribution by percentage of Society members and engineer-nuts:

CLASS	PERCENTAGE IN CLASS	
	Members	Nuts
Honorary	0.2	0.0
Life	7.6	16.4
Member	25.4	30.9
Associate Member	38.7	34.5
Affiliate	0.4	0.0
Junior	27.7	18.2
Student		1.9
Anonymous		6.0
Non-member		17.5

Add to that a contributed definition: An engineer-nut is a chap who quits the shop at 5 p.m. and retires at 3 a.m."

"Then you proved statistically that the older members are more likely to be nuts?"

"Apparently. However, they may have more time to write, or may be less sensitive. You see, many of the assignments to the Club are just problems, but the rest have been converted into puzzles by some 'catch.' Overlooking the catch, a perfect mathematical analysis may be marked zero, which hurts the sensitive fellow. We older chaps have gotten over the fear of appearing ridiculous."

"That's as sensible as realizing that amputation will not cure baldness. Does the Club have a geographical locus?"

"No. The distribution by states is like that of the Society, except that there is only one from all of New England. Serious bunch, those down-east Yankees. I was born one, but outgrew it. Per capita, Maryland is out in front."

"Just one more question ...."

"This must be the 64-dollar one!"

".... What kind of a puzzle does an engineer like best?"

"He bites hardest on pure algebra, preferring cut-and-try to Horner for solution of cubics and quartics. He nibbles brilliantly on the maxima-minima of calculus, but gropingly on Diophantics. He has no appetite for engineering puzzles unless served with an unusual aperitif.

"There may be a good reason for this latter. Perhaps an engineer-nut is still sane enuf to know that he can't afford to guess on a professional problem. Now, if you'll excuse me, I'll finish this postal to a chap who contributed a new method for trisecting an angle."

Those cards, with the phonetic signature "NeRo," are his trademark. We said "Thanks" and tiptoed away, forgotten already.—R. R. R.

* *More or less—no record kept.* ED.

Civil Service Opportunities

ENGINEERING positions to be filled from Civil Service lists are becoming more numerous. To attract applicants, education and experience requirements have been lowered, the Civil Service Commission has announced.

Positions are open in grades ranging from Assistant Engineer at $2,600 a year, through Chief Engineer at $8,000 a year. No written test will be given, and applicants will be rated on the basis of their experience records.

Applications and complete information may be obtained at first- and second-class post offices or from the U.S. Civil Service Commission, Washington, D.C.

Army Announces College Training of Soldiers

INITIATION of a program for the selection of a limited number of enlisted Army men for training at designated colleges has been announced. To be eligible for specialized training under the plan, which includes the several branches of civil engineering, applicants must meet three requirements: (1) they must have a grade of 110 or better on the Army classification test; (2) they must be graduates of an accredited high school and between the ages of 18 and 21 (not yet 22); and (3) they must have completed or must be in the process of completing the regular training of the Army.

Men not now in the Army will be eligible after induction to participate in the program, which is being administered by the Army Specialized Training Division. This is under the direction of the Commanding General, Services of Supply. Further details may be secured at any Army induction center.

U.S. Naval Reserve Commissions Still Available

THE RECENT Presidential Order closing enlistments in the Armed Forces does not affect the application for a commission in the U.S. Naval Reserve. Anyone between the ages of 19 and 50 can apply now.

To determine what particular experience is needed, address your inquiry to your nearest Officer in Charge, Office of Naval Officer Procurement.

Fellowship Offered at University of Maryland

THE UNIVERSITY of Maryland, in cooperation with the National Sand and Gravel Association, offers a fellowship for graduate research on appropriate problems related to the sand and gravel industry. It is designated as the Stanton Walker Fellowship. Fellows enter upon their duties on July 1, and continue for 24 months, including one month each year for vacation. The fellowship amounts to $600 for the year and is paid in twelve monthly installments. Opportunity for an increase in stipend is offered those fellows demonstrating more than average ability and interest in the research work.

This fellowship is open to graduates in engineering, from an accredited college or university, who are qualified to undertake graduate study and research work leading to a Master's degree. Applications for this fellowship will be received up to May 1, 1943, and forms for this purpose may be secured by writing to the Dean of the Graduate School, University of Maryland, College Park, Md.

Brief Notes

CORNELL UNIVERSITY will again offer 30 or more John McMullen Regional Scholarships in Engineering to men qualified to enter the College of Engineering in June or September. These scholarships pay normally $400 a year, but now $600 if the student elects the three-term accelerated program. These scholarships are offered annually in 15 districts covering all the United States except the State of New York, where other scholarships offered by the state are available. Application must be received by March 1, and candidates who receive final consideration are required to take the Scholastic Aptitude Test of the College Entrance Examination Board. Applica-

tion blanks have been distributed to high school principals and to head masters of preparatory schools throughout the country, and may also be obtained from the Chairman of the Committee on Scholarships, College of Engineering, Cornell University, Ithaca, N.Y.

* * * *

RECENTLY the Massachusetts Institute of Technology announced the setting up by its City Planning Division of an Urban Redevelopment Field Station with funds granted by the Albert Farwell Bemis Foundation. One of the important problems now being studied by this Field Station is the rehabilitation of urban residential areas where existing buildings are in sound structural and sanitary condition but where the neighborhood pattern is obsolete. Careful estimates are being prepared of both capital and operating costs of bringing conditions in such areas into line with modern habits of living, particularly in respect to the local street system and the adequacy of parks, playgrounds, and other community facilities.

NEWS OF ENGINEERS

Personal Items About Society Members

MEMBERS of the San Francisco Section who have recently entered the armed services include William T. Ingram, from sanitary engineer for the San Joaquin County Local Health District, to captain in the U.S. Public Health Service, with headquarters in San Francisco; Raymond R. Ribal, from principal assistant engineer for the East Bay Cities Sewage Disposal Survey, to major in the Balloon Barrage Unit of the U.S. Army; Benjamin Benas, from superintendent of the Richmond-Sunset Sewage Treatment Plant in San Francisco, to captain in the Corps of Engineers, U.S. Army, stationed at Vancouver, Wash.; Julian L. Bardoff, from junior engineer for the East Bay Cities Sewage Disposal Survey, to lieutenant in the Ordnance Department of the U.S. Army, located at Fort Sill, Okla.; S. Myron Tatarian, from junior hydraulic engineer in the San Francisco Water Department, to ensign in the U.S. Naval Reserve, stationed at Norfolk; and Charles S. Moore, from engineer with Huber and Knapik, San Francisco consultants, to ensign in the U.S. Naval Reserve at Norfolk.

RALPH L. HARDING, a partner in the Cleveland engineering and architectural firm of Wilbur Watson and Associates, was recently awarded the honorary degree of doctor of engineering by the Case School of Applied Science. Mr. Harding, who has been connected with Wilbur Watson for a number of years, is an alumnus of the Case School.

HARRY A. SERAN, of San Antonio, Tex., has been appointed special assistant to the vice-president and general manager of the shipbuilding division of the Consolidated Steel Corporation at Orange, Tex.

H. A. BRANSFORD, JR., has been transferred from the position of sales engineer in the Service Bureau of the Penn Dixie Cement Corporation, to that of director of the war products department of the same company. He is now located at Richard City, Tenn.

JOHN N. EDY, until lately assistant commissioner for administration of the Public Housing Authority in Washington, D.C., has taken up new duties as city manager of Houston, Tex. Before going to Washington in 1935 Mr. Edy had been city manager of Dallas, Tex., and Flint, Mich.

ROBERT E. CYPHERS, JR., has been commissioned an ensign in the Civil Engineering Corps of the U.S. Naval Reserve. At present he is in the Public Works Division of the Mare Island (California) Navy Yard. Before he was commissioned Mr. Cyphers was junior hydraulic engineer for the Tennessee Valley Authority at Fountain City, Tenn.

J. M. WOLFE recently severed his connection with the TVA in order to accept a position with the Atlanta and West Point Railroad. He will be assistant engineer of its Atlanta-Montgomery-Salem division, with headquarters in Atlanta, Ga.

THURMOND A. MUNSON was called to active duty in October, with the rank of major, and is now stationed at the headquarters of the 8th Corps Area Service Command at Dallas, Tex. Until lately Major Munson was professor of hydraulic engineering at the Agricultural and Mechanical College of Texas.

GEORGE D. PROCK, formerly junior hydraulic engineer for the U.S. Geological Survey at Pecos, Tex., is now instructor in civil engineering at the Agricultural and Mechanical College of Texas.

W. K. ADAMS has been promoted from the position of associate engineer in the U.S. Engineer Office at Denison, Tex., to that of chief of the relocation section.

PHILIP BARBER, JR., assistant division engineer for the Humble Oil and Refining Company, at New Orleans, La., has been commissioned a lieutenant in the Civil Engineering Corps of the U.S. Navy, and ordered to overseas duty.

BENJAMIN A. MORGAN, JR., recently resigned as resident engineer for the J. E. Sirrine Company, of Greenville, S.C., in order to accept a commission as first lieutenant in the Antiaircraft Forces.

CARL A. ANDERSON is now a major in the Corps of Engineers, U.S. Army, and has been assigned as area engineer of the Upper Columbia River area at Wenatchee, Wash. He was previously district engineer for the San Carlos Irrigation and Drainage District at Coolidge, Ariz.

RAY E. MACKENZIE, who is on the staff of the U.S. Engineer Office, has been transferred from Portland, Ore., where he was senior engineer, to San Francisco, Calif., where he will serve in a similar capacity.

UEL STEPHENS was recently appointed city water superintendent for Fort Worth, Tex. Prior to taking up his new duties he was regional construction adviser for Region 8 of the Federal Public Housing Authority, with headquarters in Fort Worth.

RICHARD PARK, colonel, Corps of Engineers, U.S. Army, has been transferred from Portland, Ore., where he was division engineer for the North Pacific Division, to Seattle, Wash. He will head the new Pacific Division office recently established there. COL. HERBERT J. WILD has also been transferred from Portland to Seattle.

B. A. WHISLER, associate professor of civil engineering at Iowa State College, has been commissioned a lieutenant in the Sanitary Corps of the U.S. Army, and assigned to Washington, D.C.

CHARLES M. MARDEL has resigned as civil engineer for the Pacific Gas and Electric Company at San Francisco, Calif., in order to accept a position as plant engineer at the San Andreas (Calif.) plant of the Calaveras Cement Company.

LEON GOTTLIEB has gone to Camp Claiborne, La., where he will assume duties with the Corps of Engineers, U.S. Army. He was recently commissioned a captain. Prior to being commissioned, Captain Gottlieb was chief bituminous engineer for the Alabama State Highway Department.

ROY T. MESSER, for the past seventeen years assistant traffic engineer for the Iowa State Highway Commission, has been granted a leave of absence in order to accept a commission as lieutenant (jg) in the Navy.

GEORGE GILLETTE, colonel, Corps of Engineers, U.S. Army, is now district engineer for the Boston (Mass.) district office. He was formerly executive officer of the Engineer Replacement Training Center at Fort Belvoir, Va.

THEODORE T. KNAPPEN announces that he has withdrawn as a partner in the New York consulting firm of Parsons, Klapp, Brinckerhoff and Douglas in order to establish an engineering practice under his own name. His new office will be located at 132 East 72d Street, New York City. Mr. Knappen has been with Parsons, Klapp, Brinckerhoff and Douglas for the past five years, devoting his time largely to the firm's operations in South and Central America.

LELAND H. HEWITT, colonel, Corps of Engineers, U.S. Army, has assumed command of the 52d Combat Engineer Regiment at Camp Butner, N.C. He was formerly district engineer at Galveston, Tex.

WILLIAM W. STUDDERT was recently promoted from the rank of lieutenant in the Civil Engineering Corps of the U.S. Naval Reserve to that of lieutenant commander. He is in charge of outside engineering on construction of a Marine Corps installation in North Carolina.

C. C. COYKENDALL has returned to his position as administration engineer for the Iowa State Highway Commission, with headquarters at Ames, after serving as assistant project manager for the Lytle-Green companies on the construction of the Alcan Highway.

CHARLES H. PURCELL, previously chief

engineer of the San Francisco–Oakland Bay Bridge and California state highway engineer, has been named state director of public works.

JOSEPH M. WERBLOW is now an ensign in the U.S. Naval Reserve attached to the Public Works Department of the U.S. Naval Training School at Noroton Heights, Conn. He was formerly a junior engineer in the Bureau of Bridges, New York State Highway Department.

JOHN S. GILLESPIE, acting district engineer for the West Virginia State Road Commission at Huntington, W. Va., has been commissioned a lieutenant in the Civil Engineer Corps of the U.S. Naval Reserve, assigned to the 45th Construction Battalion at Camp Peary, Williamsburg, Va. Lieutenant Gillespie's position as acting district engineer will be filled by J. N. WALLACE, until recently district maintenance engineer.

CARTER L. BELL, who is on the staff of the Lummus Company, has been transferred from the position of resident manager in charge of the New York Ordnance Works at Syracuse, N.Y., to Houston, Tex., where he will be in charge of constructing the aviation gasoline-butadiene stock plant for the Crown Central Petroleum Corporation.

JOHN L. FRANZEN, city manager of Oregon City, Ore., has been appointed director of all activities at "Kaiserville," Portland's huge unit housing project.

DECEASED

ANDREW JACKSON ADCOCK (Assoc. M. '40) senior resident engineer for the Texas State Highway Department at Van Horn, Tex., died in July 1942. He was 68. For several periods in his life, Mr. Adcock was in private practice, and he had been with the Big Valley Irrigation Company at Barstow, Tex., and the Consolidated Reservoir Company at Grandfalls, Tex. Since 1921 he had been with the Texas State Highway Department, serving successively as resident engineer for Reeves County and for several other counties, and (from 1938 on) as senior resident engineer.

THOMAS WARD BAILEY (M. '29) district engineer for the Texas State Highway Department at Del Rio, Tex., died on November 18, 1942. Mr. Bailey, who was 68, had been with the Highway Department since 1927. At the outset of his career (1898 to 1904) he was with the Massachusetts Harbor and Land Commissioners. He, then, (1904 to 1917) maintained a civil engineering and surveying practice at Plymouth, Mass. In the latter year he went overseas with the 101st Engineers, having the successive ranks of first lieutenant and captain. Upon his return to the United States, he became division engineer for the Holway Engineering Company at Tulsa, Okla.

WALTER CHARLES BARTELT (Assoc. M. '29) field supervisor of street construction for the Milwaukee (Wis.) Department of Public Works, died on December 20, 1942. He was 48. Mr. Bartelt's early experience was with the Wisconsin State Highway Commission. From 1917 to 1919 he served as a second lieutenant with the 527th Engineers, U.S. Army—part of the time overseas. From 1920 to 1925 he was highway engineer for Ozaukee County, Wisconsin, and from 1925 to 1926 was in private practice. Since the latter year he had been in the employ of the City of Milwaukee.

EDWARD CROSBY BEBB (Assoc. M. '07) principal engineer for the Federal Power Commission, in Washington, D.C., died recently. Mr. Bebb, who was about 70, was with the U.S. Reclamation Service (now the Bureau of Reclamation) from 1903 to 1921. During this period he was engaged on the Belle Fourche Project in South Dakota, the Lower Yellowstone Project in Montana and North Dakota, and other projects. He became connected with the Federal Power Commission about twenty years ago.

WILLIAM ETHELBERT BELKNAP (M. '97) of Hollywood, Calif., died on October 1, 1942, at the age of 75. Early in his career (1889 to 1894) Mr. Belknap was with the Pennsylvania Railroad, which he served in varying capacities. From 1895 to 1897 he was engineer for the Brooklyn (N.Y.) Department of City Works on the Wallabout Improvement; from 1897 to 1902, assistant engineer for the New York Department of Docks and Ferries; and from the latter year until his retirement in 1911 was in the coal business as secretary and treasurer of the Communipaw Coal Company, in Jersey City, and of Burns Brothers, New York and New Jersey coal company. Long a member of the Society, Mr. Belknap served as Director from 1910 to 1912.

GEORGE HENRY BLAKELEY (M. '95) engineer and steel executive, of Bethlehem, Pa., died at the home of his son in Newport, R.I., on December 24, 1942. Mr. Blakeley, who was 77, was with the Passaic Steel Company from 1890 to 1902. In 1906 he became connected with the Bethlehem Steel Company, serving from 1908 to 1927 as manager of the structural steel department. From the latter year until 1941 he was vice-president of the Company. During part of this period he was also president of the McClintic-Marshall Corporation. Mr. Blakeley was responsible for numerous improvements in the manufacture of structural steel, including broad-flange structural steel sections.

HJALMAR LUTHER BLOMSHIELD (M. '28) chief construction and maintenance engineer for the Pennsylvania Salt Manufacturing Company at Wyandotte, Mich., died on December 19, 1942. He was 55. Mr. Blomshield was with the Pennsylvania Salt Manufacturing Company from 1907 on—first as chief draftsman and assistant engineer and (after 1910) as chief construction and maintenance engineer.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

BRYAN CHEVES COLLIER (M. '07) president of the Cement Gun Company, Inc., of Allentown, Pa., died on December 14, 1942, at the age of 72. Early in his career Mr. Collier was field engineer on the construction of the Broadway and Seventh Avenue subways, and later (1910 to 1912) served in a similar capacity on the construction of Kensico Dam. From 1916 on he was in Allentown as general manager and president of the Cement Gun Company, in charge of the development and promotion of the gunite process. He acted as consultant on gunite problems in all parts of the world.

WALTER J. FUSTON (M. '28) consulting engineer of Garland, Tex., died on December 14, 1942. Mr. Fuston, who was 58, had been in private practice since 1920—first as a member of the firm, Fuston and Van Valkenburgh, and later as Walter J. Fuston, Structural Engineers. Earlier in his career (1909 to 1915) he was with the J. F. Strickland Company, the Texas Traction Company, and the Southern Traction Company at Dallas, Tex.; and from 1916 to 1920 he was with the Mosher Manufacturing Company at Dallas.

HAROLD W. HUDSON (M. '12) consultant and chief engineer of construction for Madigan-Hyland, Long Island City, N.Y., died in a New York hospital on January 15, 1943, at the age of 67. From 1903 to 1917 Colonel Hudson was with the Pennsylvania Railroad, for which he supervised the building of the Hell Gate Arch Bridge, the East River Tunnels, and the Sunnyside Yards in Long Island City. In the latter year he went overseas with the 11th Engineers, becoming chief engineer of the Transportation Corps with the rank of lieutenant colonel. He was awarded the Purple Heart of the U. S. Army and the French Legion of Honor. Later he was with the New Jersey State Highway Department on the location, design, and construction of the "Pulaski Skyway." More recently he was with the Triborough Bridge Authority—in charge of the construction of the Triborough Bridge and approaches and the Bronx–Whitestone Bridge. Colonel Hudson served as Director of the Society from 1939 to 1941.

DAVID CLAYTON JOHNSON (M. '17) president of the New York Steam Corporation and vice-president of the Consolidated Edison Company, died at his home in New York City on December 19, 1942. He was 57. In 1918 Mr. Johnson went to the National City Company as manager of the public utilities department. He was elected director of the New York Steam Corporation in 1922, and in 1927 left the National City Company to become vice-president of the New York Steam Corporation. He was elected president of the latter organization in 1928, and vice-president of the Consolidated Edison Company in 1937. Mr.

Johnson was co-author of *Yields of Bonds and Stocks*, a widely used financial reference book.

Guy Theodore Kuntz (M. '20) of Portland, Ore., died at the U.S. Veterans Hospital at Walla Walla, Wash., on December 22, 1942, at the age of 61. Much of Mr. Kuntz' career was spent in railroad work. From 1911 to 1916 he was locating engineer and superintendent of construction for the Gulf, Florida, and Alabama Railway; and from 1917 to 1933 he was successively assistant engineer and construction engineer for the Union Pacific. In 1934 he became construction engineer for the U.S. Treasury Department at Terre Haute, Ind., and later served the Federal Works Agency in a similar capacity.

John McNeal (M. '03) of Easton, Pa., died in a Harrisburg (Pa.) Hospital on December 2, 1942. Mr. McNeal, who was 73, had been in Harrisburg since 1934 as a civil engineer for the U.S. government. For several periods, earlier in his career, he served as city engineer of Easton, and from 1910 to 1916 as city engineer of Columbia, S.C. In the latter year he returned to Easton and, with Frank McInerney as a partner, maintained a contracting business until 1933.

George Hume Simpson (M. '80) of Bellevue, Pa., died on December 11, 1942, at the age of 94. A native of Scotland, Mr. Simpson spent his entire engineering career in this country. His early experience was in railroad work. From 1885 to 1899 he maintained a consulting practice in Terre Haute, Ind. During this period he served twice as city engineer of Terre Haute and, for some time, as engineer for Vigo County, Indiana. In 1899 Mr. Simpson entered the employ of the Pittsburgh Department of Public Works, remaining until 1906 when he retired.

Theodore Alfred Straub (M. '10) director of the Fort Pitt Bridge Works, Canonsburg, Pa., died on March 9, 1942, though the Society has just heard of his death. Mr. Straub, who was 73, had been with the Fort Pitt Bridge Works since 1896. He served the organization, successively, as general manager, vice-president, and president. He was elected director in 1941.

Henry Aylesbury Stringfellow (Assoc. M. '20) who was with the War Production Board, in Boston, Mass., died on November 4, 1942, at the age of 53. Sales development work had taken Mr. Stringfellow to China, Japan, and the Philippines as well as to many parts of this country. He had also been in Colombia—as chief engineer of the Aqueducto Municipal de Barranquilla. At one time he was a member of the Kansas City (Mo.) consulting firm, Kiersted and Stringfellow, and more recently was development engineer for the E. W. Bliss Company, of Brooklyn, N.Y.

James Boorman Strong (M. '13) president of Bay View Harbor Estates, Inc., of Setauket, N.Y., died on November 10, 1942, at the age of 66. In 1902—after several years in railroad work—Mr. Strong became connected with the Ramapo Iron Works, serving until 1922 as general manager and vice-president. From 1922 to 1936 he was president of the Ramapo Ajax Corporation—a consolidation of the Ramapo Works, the Ajax Forge Company, and the Elliot Frog and Switch Works. In 1937 he became consulting engineer for the Bay View estates.

John William Woermann (M. '02) consulting engineer of Chicago, Ill., died on December 8, 1942. He was 74. Until his retirement in 1939 Mr. Woermann held the post of principal senior engineer for the First Chicago District of the U.S. Engineer Office. Earlier he had served as resident engineer on the construction of numerous river and harbor works for the government in the Middle West, his entire career having been spent in the service of the War Department.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From December 10, 1942, to January 9, 1943, Inclusive

Additions to Membership

Aarons, Aaron (Jun. '42), Ensign, CEC-V (S), U.S.N.R., 913½ North Soto St., Los Angeles, Calif.

Alden, Lee Halbert (Jun. '42), Eng. Asst., Bethlehem Steel Co. (Res., 6 East 4th St.), Bethlehem, Pa.

Aldridge, Alfred George (Assoc. M. '42), Chf. Surv., Wilson & Co., 311 Kansas (Res., 619 West 3d), Liberal, Kans.

Allen, Lloyd Edmund (Jun. '42), Associate Junior Engr., Seattle-Tacoma Shipbuilding Corp. (Res., 115 South G St.), Tacoma, Wash.

Anderson, Frederick Wilbur (Jun. '42), Stress Engr., Boeing Aircraft Co., Plant 2 (Res., 5004 Seventeenth, N.E.), Seattle, Wash.

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Members	5,868
Associate Members	7,090
Corporate Members	12,958
Honorary Members	36
Affiliates	71
Juniors	5,329
Fellows	1
Total	18,395
(Total Jan. 9, 1942	17,472)

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